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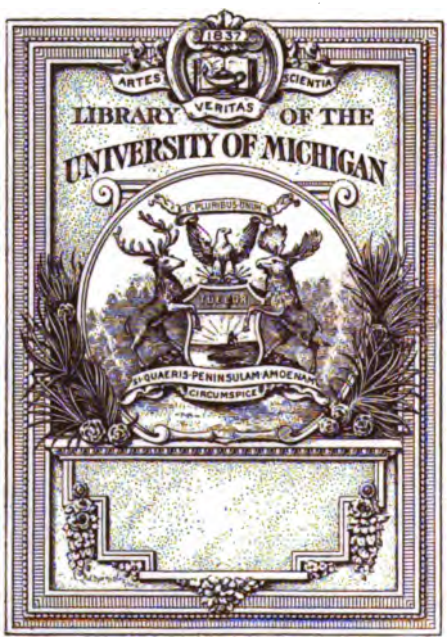

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NEW HAMPSHIRE AGRICULTURE.

TWELFTH ANNUAL REPORT

OF THE

BOARD OF AGRICULTURE

FOR THE YEAR ENDING

MAY 1, 1883.

BY JAMES O. ADAMS, SECRETARY.

CONCORD:
PARSONS B. COGSWELL, PUBLIC PRINTER.
1883.

BOARD OF AGRICULTURE.

ORGANIZED AUGUST, 1870.

MEMBERS.

MOSES HUMPHREY, Concord, *Chairman.*

JAMES O. ADAMS, Manchester, *Secretary.*

W. H. H. MASON, Moultonborough.

HIRAM PARKER, Lempster.

GEORGE K. HARVEY, Surry.

WILLIAM H. HILLS, Plaistow.

ALBERT DEMERITTE, Durham.

DAVID H. GOODELL, Antrim.

SIDNEY B. WHITTEMORE, Colebrook.

CHARLES W. HACKETT, Belmont.

JOHN E. CARR, North Haverhill.

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STANDING COMMITTEES,

Of each of which the Secretray is, *ex-officio*, a member.

Finance—Humphrey and Parker.

Experimental Work—Hackett and Hills.

Farm Machinery—DeMeritte and Goodell.

Hygiene and Disease—Mason and Hackett.

Horses—Whittemore and Humphrey.

Neat Cattle—Goodell and Carr.

Sheep, Swine, and Poultry—Harvey and Mason.

The Dairy—Parker and DeMeritte.

Fruits and Vegetables—Hills and Harvey.

Miscellaneous Matters—Carr and Whittemore.

ROOMS OF THE BOARD OF AGRICULTURE,

CONCORD, MAY 1, 1883.

To His Excellency the Governor:

In conformity to the requirement of the statute, the Secretary commits to the hands of the Public Printer the manuscript of the Twelfth Annual Report of the Board of Agriculture, that in due time and proper form it may be submitted to Your Excellency and to the citizens of the state.

JAMES O. ADAMS, *Secretary.*

ANNUAL MEETING.

The first meeting for the year just past was held in the rooms of the board in Concord, on Thursday, September 21, 1882. It was the annual meeting for business and the triennial election of officers. The resignation of Mr. Sanborn, who had removed from the state, was read and accepted, and a unanimous expression of regret was given on the loss of a valuable member.

A quorum being present, certificates of reäppointment and qualification were presented by Moses Humphrey for Merrimack county, and W. H. H. Mason for Carroll county,—Messrs. Harvey, Parker, Goodell, Hills, DeMeritte, and Whittemore holding over. Vacancies existed in the counties of Belknap and Grafton.

Proceeded to the election of chairman for three years from the date of the meeting, and the whole number of votes was found to be cast for Moses Humphrey, who was declared elected.

Voted, To elect a secretary for the ensuing term, and unanimously chose James O. Adams, of Manchester. The oath of office was administered by Hon. Moses Humphrey, justice of the peace for Merrimack county.

Voted, That the chairman and secretary appoint the standing committees, which were subsequently announced, after vacancies in the board had been filled, as follows, the secretary by vote being a member of each committee:

Messrs. Humphrey and Parker, on Finance.
Messrs. Hackett and Hills, on Experimental Work.
Messrs. DeMeritte and Goodell, on Farm Machinery.
Messrs. Mason and Hackett, on Diseases of Animals.

Messrs. Whittemore and Humphrey, on Horses.
Messrs. Goodell and Carr, on Neat Cattle.
Messrs. Harvey and Mason, on Sheep, Poultry, and Swine.
Messrs. Parker and DeMeritte, on Dairy.
Messrs. Hills and Harvey, on Fruits and Vegetables.
Messrs. Carr and Whittemore, on Miscellaneous Matters.

Voted, To hold less meetings, but to extend them when practicable to two days' continuance.

Voted, That the times and places for holding meetings be left to the Secretary and the member for the county in which they are to be held.

Voted, That more experimental work be performed, and that the needed facilities be secured by the Secretary, so far as circumstances admit.

Voted, That each member attend the New England and State fairs, and the local exhibitions in his own county, and contribute to their success by counsel and by the presentation of articles for competition.

Voted, To recommend to farmers to hold field meetings for the practical study of different usages in different sections of the state, and for the formation of more intimate acquaintances.

Reports were made showing the condition of crops, the favorable and unfavorable meteorological influences existing in different sections, the injury done by destructive animals, birds, and insects, and also by mildew, blight, fire, and other agencies.

There was a general expression in favor of the formation of farmers' clubs, granges, and town agricultural associations. The board enjoined upon each member the duty of urging farmers to attend fairs and farmers' meetings, to visit reading-rooms, and by all means to supply their homes with well selected newspapers and magazines, and in an informal and impressive way reäffirmed their confidence in the College of Agriculture and the Mechanic Arts.

To avoid frequent formal meetings of the board, it was decided, as has been the practice before, to leave the determination of the questions constantly arising to the standing committees, and, in case of immediate action, to the chairman and secretary.

PUBLIC MEETINGS.

The board has done its usual amount of public work during the year, though with a less working force. The resignation of Mr. Sanborn removed from state limits the chief worker in the board. The demands of private business forced other members to neglect their official duties, consequently extra labor has been thrown upon the secretary and a few willing members of the board.

Meetings for the public discussion of agricultural topics have been held in all sections of the state where there has been a general desire expressed for them.

MEETING IN MANCHESTER.*

Early in the winter an arrangement was made, through the efforts of the secretary, for a convention of the board of agriculture, the state society, the patrons of husbandry, and the trustees and professors of the agricultural college, to be held in Manchester early in January. The meeting was held according to the announcement. Though the attendance was not large, there were present many of the best farmers in the state, with intelligent representatives from Vermont and Massachusetts.

The meeting was called to order by Hon. Moses Humphrey, of Concord, chairman of the State Board of Agriculture; and Col. Aaron Young, of Dover, secretary of the State Agricultural Society, acted as secretary.

Mr. Humphrey stated the objects of the meeting, and in brief remarks eulogized the business of agriculture. He said that the old board of agriculture in this state was organized sixty-three years ago, being the first organized in New England. It lived

* From the report in *Mirror and Farmer*.

a year, made one report, and died. In 1850 the State Agricultural Society was organized, and in 1870 the present board was organized. The order of the Patrons of Husbandry was organized some ten or twelve years ago. All these organizations have served to awaken much interest in agriculture in our state, and these efforts have resulted in better methods of culture, in the improved character of cattle and horses, and, in fact, in improvements in nearly every respect. In farm machinery, too, we notice great improvement, traced to the efforts of the societies, and meetings, and the newspapers. We are still going ahead, and he expected to see greater improvements in agricultural matters before he died. He hoped all the organizations represented here would take free part in the meeting.

J. O. Adams, secretary of the board of agriculture, stated what arrangements had been made for the meeting, and that the presidents of the different organizations would act as presiding officers at different sessions. A question-box was provided, and it was hoped that members would avail themselves of its privileges.

Col. Riddle read letters from Hon. George B. Loring and Col. T. J. Whipple, regretting that they could not be present on account of official and professional engagements. Col. Whipple, in his letter, alluded to the work of Prof. J. W. Sanborn while on the college farm, the value of the experiments conducted by him while there, and of the necessity for continued work of this character, such as few individual farmers are able to undertake, like the testing of agricultural implements, which are becoming a necessity in the present practice of farmers. He also spoke of experimental work in other states, such as Connecticut and New Jersey, and alluded to the importance of knowing whether farmers can profitably extend and modify operations by the purchase of chemicals, and in what way.

As a little time was at command before dinner, on invitation, B. P. Ware, of Marblehead, member of the Massachusetts board, gave his experience with ensilage, remarking that he was believed at home, and he could not understand why one could not be credited when speaking of ensilage as well as when talking about turnips. His experience with it covered two years. He did not claim to take out anything that he did not put in. Chem-

ists acknowledge no loss to grass in drying down to hay. How do we know? As usually secured, grass gives better results. He claims economy in handling, and a gain in digestion and assimilation, as compared with hay or corn cured in the ordinary way; and the water necessarily handled is brought to the barn in warm weather, and the cattle get it in the feed instead of going out for it in cold weather. Is positive that no better milk or butter can be produced by other feeds. This he claims is especially true regarding the color of the butter made from it in winter. Admits that the acidity arising from it to the atmosphere of the stable may indirectly affect the milk, if left warm and uncovered near the stable, as every one knows the extreme sensitiveness of milk in this particular. Stated that he had fed the same cows a year or more with it, and had failed to discover that they had aborted, or lost any teeth by reason of it. With high cultivation a cow could be kept a year on the hay grown on an acre of ground. He claimed that similar culture would produce from fifteen to forty tons of green corn, and he considers three tons of this, properly ensilaged, equivalent to one ton of hay, which represents, as he puts it, five cows wintered to the acre. Ten or twelve tons was a very low estimate of green corn per acre, and thirty not difficult to produce. He gave a description of the manner of building his silo, and method of feeding, and said that he would be thorough with cemented work under ground, and use wood above ground, being sure to have the wood-work supported by sufficient frame-work to resist the enormous side pressure in a deep silo. He had brought his cows down to the ensilage, feeding from a door within six feet of the bottom in the basement.

An adjournment was ordered at this point.

On reassembling in the afternoon, George A. Wason, master of the state grange, took the chair, and, after a word of apology for occupying the place, introduced Mr. Joseph B. Walker, of Concord.

Mr. Walker took for his topic, "Prospective agriculture in New Hampshire." Our New Hampshire agriculture appears in the light in which one looks at it. Some people are born timid and some "tired," and they tell us New Hampshire farming is gradually becoming a thing of the past. They cite our decrease

in population in the agricultural towns; the unoccupied farms and unfilled school-houses; state that the people have also declined in quality; that our forests are being rapidly destroyed; that we import our wheat and corn, which we ought to raise ourselves; that our number of cattle and sheep has decreased, and our hay crop with them; and that our young men are going West.

Let us look at these allegations. We have already passed the decline complained of in regard to a decrease in population. Abandoned farms have, in many instances, been transferred to forest and pasture land, and the transfer is wise. We have lost some of our good citizens, but the agencies which made them so still remain. Our forest removal has been going on since the red men surrendered the soil to our fathers. The timber crop was made to be removed, the same as other crops. It has never promoted the aridity of our summers. Water has been saved in reservoirs to balance that lost by removal of the forests. We have long had to import wheat and corn, but we raise more than we ever did, and do it much cheaper than formerly. Our oxen have been replaced by horses. Our young people will go elsewhere, if it is for their interest. Our little state cannot hold our increasing population: we do not expect it. Our location is very much in our favor: it is as important a factor in the problem of successful farming as is soil.

New Hampshire farmers will, in the future, be able to trade hand in hand with the consumer, and not traverse a continent and an ocean to find a market.

There are lighter hues to the picture: our agriculture is being lifted out of chaos. Our agricultural college stands at the head of the agencies which are doing this. It has sent out seventy-five graduates, about one third being now farmers, having had about two hundred students in all since it was founded. Its course of study is ample and comprehensive. Its doors are open to any young man in New Hampshire. The board of agriculture is another agency. It has done much to impart information, and awaken our agriculturists. It has held meetings at the rate of about thirty or more a year, and nearly every town in the state has been favored by them. Another organized agency, which is doing efficient work, is the Patrons of Husbandry, which commands general approbation. It has done

much to improve the social relations of our people by enlisting the services of women.

These three organizations are intellectual agencies, and from them we ought to learn something and gain something. The state, town, and county agricultural societies also assist in the work. Their teaching is *object*-teaching: they teach by sight, and not by faith.

Then there are the public farms of the state and the counties,—all useful teachers,—three of the former and ten of the latter. The experiments of the college farm have been most valuable. The asylum farm at Concord affords a great means of education in regard to milk, and the saving and applying of manure. These farms are all improved, and put in good condition in all their appointments. One of these farms produced last year crops of an average value of over $15 per acre. They are elevators of the general farming of the state, and are worth much as public exhibitions of good farming.

The example of gentlemen farmers and progressive farmers,—farms connected with public institutions (where the business is carefully conducted, and the methods successful),—has the same weight of influence from an agricultural standpoint as good living has in religion. The speaker also referred to the failure of farmers as object-teachers, although not always so easy to get at. To induce more summer visitors, institute more marketing and special production, and higher and better farming. Still greater improvement in stock requires an elevated ideal, and still more energy and personal effort. Mr. Walker, for illustration, related an incident of observation where a large block in Chicago was raised with 1,500 jack-screws, slowly, with all the business going on inside, until the whole structure was raised six feet without a crack. Elevate gradually, and at the same time, the 50,000 farmers of New Hampshire, by the silent influences mentioned, and almost unconsciously we shall find that in the near future success shall be ours.

James Fellows, Esq., of Henniker, was then called to the chair, as a representative of the grange, and accepted the position in a brief speech. He commended the address just listened to, and claimed that farming was a most profitable avocation. He closed by introducing Hon. Daniel Needham, of Massachu-

setts, who delivered a very acceptable address on "The relation of agriculture to banking."

Col. Clough, of Canterbury, took exceptions to the commendation of the national bank system as unjust, favoring the rich and oppressing the poor.

Hon. Daniel Clark, formerly United States senator, felt called on to say a word in regard to the institution of national banks. Col. Needham had not given the inside history of the measure. He then said the securities of the government were issued in 1861 and 1862, but in 1863 we did not dare to go any further, and then the national bank system was proposed; but it was resisted by the state banks, and by many of the people. It is entirely true that state bank bills were fluctuating in the different states, but the national bank system is wholly due to the necessities of the government at the time of its adoption. Every senator in New England was opposed to it. I was one of them, and Hon. Salmon P. Chase, the secretary of the treasury, called on us, and said he could not carry on the financial affairs of the government without the adoption of this system. He offered this inducement to the banks to put their arms under the government. and help it carry on the war for the Union. I said to the secretary, "You shall have my support." We then all voted for it, and as my name was called, and I responded in the affirmative, after having strongly opposed it, Judge Collamer, of Vermont, stepped to my seat, and said, "Miracles are more wonderful now than in the days of St. Paul." We passed the bill to run the government. The banks responded, and we owe to them a debt of gratitude.

Col. Clough—Would you advocate the same thing in time of peace?

Judge Clark—Not at all. It was a war measure, and I voted for it that I might help save the country.

The unfinished business of the morning was now taken up, and Mr. Hersey, of Massachusetts, took up the other side of the ensilage question, saying, in substance, that he did not own a silo, but had at different times travelled more than 1,000 miles for the purpose of examining them. He would not say that he believed the gentleman (Mr. Ware) did not preserve his ensilage perfectly, but if he had done so he had been more suc-

cessful than anybody he had yet seen. In his travels he had not yet seen a silo that was not mouldy for three inches on the outside, and six inches on top. He was afraid the gentleman did not put sufficient credit to the account of cotton-seed meal fed with the ensilage. Would the gentleman look him in the eye, and say, without qualification, that they would do as well on ensilage for steady diet as on good hay? Cattle will do well with all the dry corn-fodder they want, if they can have such a ration of meal and cotton-seed. He would raise a corn crop, and sell part of the corn on the ear, and buy more fodder; would plant more land, and hire help to raise the corn, rather than pay the money for cotton-seed meal. But the small farmer may choose, or not be able to do, either of these. The silo, in his opinion, was for the rich man, the man of means.

Mr. Ware replied, and said he only stated facts. He kept a bull all winter on nothing but ensilage, and he was fat in the spring without a particle of grain. It does not require any great skill to manage a silo and secure good ensilage. A little practice only is necessary: we have to learn by experience. It does not require any extraordinary skill. To make it successful, we should prevent fermentation. Take away heat or air, and you do this and are safe. Either keeping out the air or keeping out the heat will do this.

Mr. J. M. Connor, of Hopkinton, inquired why it would not not do to ensilage grass as well as corn, and if there is not as much profit in it, if any. He could make more butter by feeding his cows good English hay, with corn or meal, than on June grass without grain. The flow of milk usually diminishes as soon as he turns them out to pasture.

Hon. D. H. Goodell, of Antrim, has had considerable experience with the silo. There was not much difficulty in curing grass, but grass grew only two or three feet high, while corn would grow ten or fifteen feet high. Twenty-five tons of corn-fodder could be grown on an acre, and only about three tons of grass. He related his experience in visiting Dr. Bailey's silo in Massachusetts. He hoped to hear somebody who had tried the system oppose it, but all the opposition came from those who had never tried it. Those who have made failures of it have done so through lamentable ignorance. He saw no reason why

small farmers might not have a silo. Ensilage will cost about $2 per ton. His cattle come out splendidly in the spring, fed on ensilage two meals, and one of straw, per day. He never found any difficulty from feeding it. The cattle like it. Milch cows will give 20 per cent. more of milk, fed on ensilage, than if fed on good English hay. He cited numerous illustrations, showing the value of ensilage in producing flesh and fat, and increasing the flow of milk. He is satisfied that the system is all that can be reasonably claimed for it. We can raise more fodder on the farm, and have it ready for use, by the system. He would raise just as much grass as ever, but makes ensilage an extra crop.

Col. Clough, of Canterbury, said he had little faith in the system. He thought good hay, properly cured, was as good feed as any pasture or other feed.

Joseph Barnard, of Hopkinton, said he visited Mr. Goodell's stock last spring with a good deal of prejudice against the system of ensilage, and he there found stock wholly fed on ensilage and meadow hay to be in good fair beef condition, and he became convinced of the value of the system. He thought, perhaps, the rich man could do without a silo, but a poor man could not. If you do not know how to put it up, just ask your wife how she puts up preserves. This is precisely similar.

The meeting at 4.45 then took a recess until 7 o'clock in the evening.

Mr. Goodell, of the board of agriculture, presided at the evening session. The first speaker was Prof. C. W. Scott, of the college of agriculture, his subject being "Agricultural education."

There are various educational influences,—the agricultural college, the grange, and the board of agriculture. Agricultural education was first provided for about twenty-five years ago, in this country. The earlier efforts to educate young men in matters agricultural were weak and of little value. The agricultural colleges have to combine the advantages of the high school and the college, so that graduates shall stand respectably with other scientific men. They have been out of their course too often; the original United States law left the purpose of the school

indefinite. We are obliged to teach agriculture and mechanic arts. Our college is not like those in Massachusetts;—one there is an institute of technology, and the other an agricultural college, while ours combines both.

I propose to wage war for students for our agricultural college. We want one hundred students. It has had fifteen classes; there have been one hundred and eighty-three men connected with it, and seventy-three have been graduated; the largest class had fourteen men, and the smallest, one, that graduated. The work has been considerably increased, and the standing raised since the college was established; the students stand well among the people at Hanover,—a change which their quality has compelled. Of course they have not had the previous classical training that the Dartmouth students have, but they have had mental discipline, which stands them well. A Dartmouth man, by teaching school or other labor, can possibly get through on $1,000; our men can graduate for $500. Sometimes men get through and have more money than when they entered, but these are exceptional cases. Our students spend about $200 per year. The English courses are about the same in both colleges; mathematics are about the same; we have more surveying and more mechanics; in physics the courses are about the same; in mineralogy and geology we do more than they; and the same is true of botany, entomology, and chemistry. We have no metaphysics or classics. We do about the same as the academic course at Dartmouth, except we omit the two last named, and have a great deal more in science. We have three recitations a day, and the course occupies three years. The students have an opportunity after recitations to work on the farm, for which they receive twelve and one half cents per hour. Then we have scholarships which aid indigent students: the room rents are much less than at Dartmouth, and the rooms newer and better. There are more opportunities for earning money, and less expensive ways to spend it in our college, than in the other. Our work is more than we have material for. Our men are doing about double the work that similar men are doing at Dartmouth. We want more students, and we want an agricultural man there to take the place of Mr. Sanborn. If some of you manufacturing men, who have lots of money, would

endow an agricultural professorship and erect a mechanic shop there, it would be doing a great work. We also want more books, a better library; we want to develop the agricultural part; we want to strengthen that. All of our men do not intend to be farmers, but we are glad to see so many of them doing so. We think we are doing good work and graduating a good class of men, who will prove the equals of any men graduated from any college anywhere.

With an appeal for help for the college in the ways indicated, the speaker closed.

He was followed by Prof. Manly Miles of the Massachusetts College of Agriculture, who spoke upon the "Relation of nitrogen to the soil and crops." He thought the subject was one of the most important that can engage the attention of farmers. It was an old subject. Lawes, Gilbert, and Liebig had struggled with this subject for years. I do not undervalue the mineral constituents that enter into the nutrition of plants, but half truths very often lead us into error: if we don't have the whole truth we are very apt to be misled. The art must precede the science. The art of agriculture is the oldest art: one must go back to the art, the practice, the experience of ages. The experiments in nitrogen were begun by Mr. Lawes at Rothamstead, England, and were for ascertaining the truth, and I shall have to draw from them in what I say. The air is composed three fourths by weight and four fifths in volume of nitrogen in the free, gaseous form, and combined with other substances extremely minute. Neither can be used in the nutrition of plants; they can only take it in some form of nitric acid as a food. A large proportion of plants is composed of carbon, derived from carbonic acid gas from the atmosphere. The free nitrogen of the air has nothing whatever to do with the growth of plants: the experiments of Dr. Lawes prove this. The combined nitrogen, combined in one part to about twelve to fifty millions, is the only kind in the air that the plant can use. It is soluble in water, and the rain as it falls washes it out of the atmosphere. It varies constantly. It is rapidly formed near the town; not so rapidly in the country. The amount brought down by rain-fall will not exceed four or five pounds per acre. If any one states that forty-eight pounds are brought down, it is

merely a half truth; it will not bear investigation. The amount absorbed directly by the soil is less than this, and the whole amount obtained in all manners from the atmosphere must be less than ten pounds to the acre. The plants require more than this. The table below will show the amount, in pounds, of nitrogen absorbed per acre of unmanured soil by the following crops:

Wheat,	24
Barley,	24
Meadow hay,	39
Beans, about	48
Clover hay,	116
Indian corn,	40 to 60

Experiments in France in 1877 determined that the bacteria aided in the solubility of nitrogen. Certain temperatures were favorable for it; therefore there would be not so much danger of its loss from manure when drawn out in winter as in summer.

Members of the meeting then plied the speaker with numerous queries on the topic discussed, continuous cropping being regarded as the best policy to take advantage of the nitrogen. At 9:30 the meeting was adjourned till Wednesday morning.

On Wednesday morning the chairman called to order, and Secretary Adams opened the question-box. The first question proposed was, "Is the abandonment of our New Hampshire farms detrimental to agriculture?"

Mr. J. M. Connor, of Hopkinton, was called upon to answer this, which he did in the affirmative. There was a sad lack of help in our agricultural towns, and farmers had to take the refuse in too many cases. Some of our best farms are abandoned because good help could not be readily secured; because they are located on back roads, and the young people want to be out nearer the centres. We have not a sufficient force to cultivate all the land we have cleared.

Mr. John E. Carr, of Haverhill, said he knew of many farms that he wouldn't take the gift of. Many of the young men would not stay on the farm because they were not given privileges enough. The teaching of the farmers of the last genera-

tion was all wrong: they did not give the boys liberty enough or privileges enough.

Col. Clough, of Canterbury, thought one very important reason why our farms are abandoned was because our society and schools had been broken up, and the young folks had gone off into the villages and cities. Any of these abandoned farms can be placed under as good a state of cultivation as any other, right from the resources of the farm. There is no necessity for deterioration; every acre should be made better every year. A good husbandman is all that is lacking to make the farms profitable. He didn't want the state to grow up to forests, and be inhabited by wild beasts.

Other topics were introduced through the question-box, which are epitomized as follows:

The opinion that manure should be applied near the surface, and that the soil should be often stirred to assist the plant growth; that the disc harrow is the best implement yet made for the purpose of mixing the manure with the surface soil; that the roots receive nourishment even from the stones; that the cheapest place to manufacture manure is in the soil; that the presence of barn-yard manure in the soil prevents the loss of nitrogen from the soil by drainage; that clover brings up nitrogen from the subsoil that would otherwise pass off in the drainage, which is deposited near the surface for other crops when the roots and stubble are plowed in.

Prof. Manly Miles, of the Massachusetts Agricultural College, then addressed the meeting on the subject of "Breeding." The live-stock interest is a great one, and whatever will increase it is of value and importance. The foreign shipment of meat requires a first-class article to be produced by the farmers. The farmers of the East can compete with the farmers of the West in the production of all the staples, and do it successfully; and they must do it. It will not do to give it up without trying. We have great advantages over them; we have manure profits in feeding which they in the West do not have. But we must have good animals,—cattle, horses, swine, and sheep,—and the principles of breeding are the same with all these kinds. Breeding rules have been derived from the experience of practical men. Physiology helps us to explain the reason for the results

which are attained. One object must be aimed at in breeding: it will not do to attempt to combine too many, as we might fail in securing animals embodying all the types and points desired. "Breed from the best" is a rule that we cannot improve upon. But what is the best? What is the standard? We want a definite idea of the standard, and then adhere to it. Breeding is really a fine art. The breeder must have an ideal in his mind, and mold the animals to meet the model formed in his mind. It requires peculiar qualifications to excel in breeding,—a man of good judgment, persistency, and of good, lively imagination.

One of the leading principles is, that we have a law of heredity, of inheritance—"like begets like." This is true: it is a universal law, without exceptions. The young animal at birth has all the characteristics of his ancestors. All characters are inherited from all ancestors, whether by cattle, horses, or dogs. Color-blindness is one of the characters inherited in the human family. Abnormal characters are not so liable to be inherited as natural ones. The inheritance of disease is difficult to guard against; some of them are transmitted in a very singular way. There is often an interruption of it, and it makes its appearance some generations on. Characters of remote ancestors occasionally crop out, called "reversion" by Mr. Darwin, breeding back.

In breeding, we make certain characters prominent or dominant: herein comes the skill of the breeder. We must keep the most prominent and best characters in sight, and keep the poorer ones out of sight. A pedigree is only valuable to know the characteristics of the progenitors; it furnishes only a means to enable one to study the characteristics. We may seek a certain characteristic, and modify the conditions which we find in animals, to bring them up to the model fixed. Only the best, and those that follow the standard exactly, should be selected for breeding. Defects should not be allowed to enter in; the perfect balance should be maintained. Climate varies animals; so do food and the surroundings. The Kerry cattle are illustrations. Beef cattle want a short life and a merry one: profit is made by turning them into beef when young. The training and the inheritance produce the trotters. Only a few of the young will have all the best characteristics of their ancestors, and those are the

ones that must be kept and bred from to produce animals of the greatest excellence. Very rigorous selection is required to keep the type on a uniform basis. Some characters are modified, while others are being changed. Wool, for instance, is very much finer in this country than in 1840, and the mutton of the merino is much better than formerly.

There is a good deal said about in-and-in breeding: some think it exercises some mysterious influence. This was largely practised by our best breeders: they bred together animals which were alike, whether related or not, and not because they were related. In-and-in breeding is an incident, but not the end. It is done simply to intensify the dominant characters desired. The danger of it is that you fix the undesirable characters just as positively. There is no other danger. Cross-breeding has been supposed to add stamina, but I don't believe it does: it introduces conflicting characters. A pure-bred male bred upon mixed characters is permissible and profitable, and the character of the male will predominate in the product. There is no reason in the belief that in-and-in breeding diminishes the strength of the constitution and cross-breeding strengthens it. There is nothing to the theory that the male influences the outward organs and the female the inward organs of the progeny. We don't know anything about the causes of sex, or which or what determine it. Have an ideal, have clear notions, and then make rigorous selections that are up to the standard, and persistently follow it up. Only try one point at a time, and you will be likely to achieve success.

To questions, he said that it was always important to make a good and judicious selection of the males in breeding, but the male was only one half of the stock: the female must be carefully considered. He had seen instances of impregnation where the female had given forth animals of a characteristic of a former animal with which she had been coupled.

Col. John B. Clarke, of the *Mirror*, said that the talk on breeding from Prof. Miles was the most sensible he had listened to for a long time, and he wished to ask him one question before he left us in regard to this,—that was, in relation to prepotent sires. Gen. Knox was a prepotent sire. Rysdyk's Hambletonian was a prepotent sire. George Wilkes was a prepotent

sire. To change, there are prepotent sires of cows, of cattle. But there are Alphea bulls which are good for nothing in this direction now; and the same is true of dog and swine. Now these sires that are of good blood, is it desirable to breed from them? Shall we breed from an Alphea bull, for instance, who is of a good strain of blood, who gets heifers that are not good milkers?

Prof. Miles replied that this was a long story, and he had omitted it purposely. All we know is, once in a while there is a prepotent sire that does not fulfil the law. This particular instance is without correct explanation, and there are cases where we don't know all the facts. Sometimes the condition mentioned exists: we cannot explain it, but we know it exists.

Edmund Hersey, of Hingham, Mass., then addressed the meeting upon the subject of "Fertilizers and the preparation of the soil." Nature, when left with herself, has ways of her own for fertilizing the soil for the moderate growth of native plants; but man must assist her if he wants more than a moderate growth. There is an almost inexhaustible supply of material for fertilization laid up in our primeval forests by nature herself, and she will fertilize the soil, but man must assist her. How nature does this is well known. All portions of wood under combustion, and of manure, go into the air, except the mineral portions; and whatever goes into the air must come back again. Here our forests get their nutrition. The earth contains about 33 parts in 10,000 of carbon; but under different conditions it contains more,—330 parts, and even 1,300 parts, in 10,000. This is necessary in the form of carbonic acid gas for the rapid growth of plants. The carbon, having gone up by decomposition and combustion, must all come back again, but we cannot tell how. Manure in the process of decomposition has an influence upon the nitrogen of the air, and in this way it becomes available as plant food, but exactly how we cannot tell. The phosphates and potash are important elements. How do the plants feed? Not as sheep. They do not run after feed; they send out their roots as the spider spreads his net for the fly. If we know how nature works, we may be able better to assist her. The operation is something like the lamp wick which draws up the oil from below. Your soil should be properly prepared:

this is most important. The land should not be hard, for this will prevent the uninterrupted drawing up; and, too, the rains will not readily penetrate, but will run off and be lost. Moisture and air must be let into the soil to make it give up its plant food. Experience teaches us that our soil must be loose and light, and be filled with fertilizing materials; and some of it should be not thoroughly decomposed, which is lightening it up continually, and supplying the plant food as they want it. Phosphates and sand will not yield a good crop, because there is no carbonic acid gas there. Nitrate of ammonia is not the only important ingredient of nutrition of plants. The soil should be pulverized, and the fertilizing material so applied that it will be most available for plant food. The manure needs stirring as much as the soil, encouraging change and hastening decomposition, which is beneficial to plant growth. It is better to manufacture your material in the soil than in the manure heap. The ground work of the crop should be in the land where the plant food can be used readily and rapidly.

Mr. Wm. H. Hills, of Plaistow, member of the board of agriculture, inquired if nitrogen might not be taken in sufficient quantity by the plants, directly from the air; and thought if we could not use this it was a most expensive article.

Mr. Hersey said he did not profess to be a chemist, and could only speak from his own observation, and could not say whether the nitrogen entered the plants through the leaves or through the roots. Wheat takes about one half of its nitrogen from the soil, or, in other words, does not exhaust the soil of its nitrogen.

Prof. Miles said there were a good many things that we wanted to know yet in reference to this matter. The balance of evidence is setting against the theory that the plants use the free nitrogen of the air. The bean and the clover were formerly thought to take their nitrogen from the air, but Mr. Lawes's experiments show that they take it from the soil. The old methods of analysis were found not to be close enough, and nitrogen got in. The idea that they got their nitrogen from the air is a very convenient one, but there is little evidence to substantiate it. The mechanical effect of the barn-yard manure as a fertilizer is an important one, and working and pulverizing the

soil are of importance. Wheat and barley seem to have great power to take nitrogen out of the soil. Clover takes a great deal, and leaves a great deal in good form for other plants. It liberates and wastes a good deal which other plants can take: it brings up a lot from below, and leaves it for the next crop to use. Evaporation also brings up a good deal, and it is constantly in motion. The clover is, therefore, a very valuable plant. Bog lands should be drained three or four feet to produce good hay: they are not generally drained deeply enough.

In the afternoon of the second day the meeting was called to order at two o'clock, President Humphrey again in the chair. The question-box was opened, and the first taken up was, "What is the best implement for pulverizing the soil?" Some one answered, the disc harrow; others said, the acme harrow. It was urged that the ground should be well plowed first, before any harrow was used.

The next was, "My first year's use of bone-black yielded no result, and the second, good results. Why was it?" Mr. Hersey, of Massachusetts, said it was bone-black that was used, which was not soluble till the second year. If you want immediate results it should be mixed with ashes and heated, and then it would be readily soluble. Mr. Hills, of Plaistow, thought it would not pay for its application on his soil, especially for onions.

The third was, "How does the presence of a building, stone wall, pile of boards, etc., promote nitrification, if at all, otherwise than by preventing the downward drainage waste? Does any crop that covers the ground more or less perfectly promote or conserve it by retarding evaporation?" In answer, Prof. Miles said this nitrification can be worked on in various ways. It is washed down into the soil, and if you can preserve it for the plants, you have it there for use. Dark places and cool weather will preserve it. Locked-up nitrogen cannot be made use of by plants. The bacteria cannot work so well in the dark or cold, and it is, then, therefore not set free. If it is protected by buildings, it will remain there for a long time, perhaps, to be ready for use when the conditions are favorable.

The fourth: "What effect will the frost have on the nitrous

substances in the soil?" Prof. Miles said if the substances were frozen the nitrogen could not be liberated.

Mr. Ware, of Massachusetts, called up Prof. Miles on the nitrogen question again. He wanted to know where the future supply of nitrogen is eventually to come from. The professor said it was coming down from the air all the time, and we had it in manures and in artificial fertilizers. Green manure did not hold it in such form that plants could make use of it; it had to undergo its change, and wait till the bacteria had got in their work. The process of supplying it has been going on for ages; but we want it for use sooner to hasten up plant growth, and have to supply it artificially.

Mr. Hiland, of Fremont, thought our soil needed protection; that the evaporation should be prevented. It should have some covering to save the elements of nutrition which we supply it with.

President Brown thought an occasional drought was not a permanent injury to the soil. Prof. Miles agreed with him respecting certain soils.

Hon. J. B. Walker had used lime on the soil, and wanted to know where his grass had come from. Prof. Miles said lime had acted as a base for the nitrification of the organic matter, and made it available as plant food, but did not contain much nitrogen of itself.

James Fellows, of Henniker, wanted to know the effect of lime and ashes mixed. Mr. Hiland said, in practice, plaster and ashes worked well. President Brown said one or two applications of leached ashes proved profitable, but after that it did not. Prof. Miles explained the reason for this, which was, that the soil had got enough. Mr. Hills, of Plaistow, said practically leached ashes proved just as valuable as unleached: the reason probably was, the leached ashes still had plenty of potash left in them for the wants of the soil; but the unleached would leave potash over for future crops. Mr. Fellows said the effect of ashes remained long in the soil, and he got good results by application on a clay subsoil. President Brown thought unleached ashes best. Mr. J. L. Gerrish, of Webster, said he had long used ashes on his farm, and much depended on the influence of the rain-fall immediately after their application. He thought it a safe thing to apply.

Hon. John D. Lyman, of Exeter, was then introduced as the lecturer of the State Grange, Patrons of Husbandry, who spoke on "The necessity of additional legislation for the benefit of agriculture in our state." He prefaced his remarks by advising farmers to use ashes if they proved profitable to them, and discard the use if they did not. Chemistry is yet in its infancy, and we must make these trials for ourselves. We have a state of more water-falls, more lakes, and more ponds than any other of equal size. What can be done with it? The intention was, in its creation, to make all these things useful. It is an excellent place for summer boarders, which will bring into the state two or three millions of dollars, and furnish good markets for our farmers. We have an immense water-power, which should all be used, bringing in population for our farmers to clothe and feed, and furnish the building material, etc., for. We should use the locomotive to draw the goods instead of the oxen. But the people should control all these forces and these corporations, and see that they themselves should continue the rulers of the state. He thought it was wise legislation to exempt swamp lands from extra taxation after they were drained; and the law should allow a man to drain his swamp land through the land of his neighbor, by paying him due damage. It would be constitutional, if the public health or beauty of the scenery required it. Mill property is exempt from taxation for periods of ten years. We find no fault with this; but the farmers should be remembered in these distributions of favors. The state can, by a little judicious aid, help our farming interest materially. Pine timber and oak timber are more profitable crops than pine wood and oak wood; one brings $10 per cord, and the other $1 or $2. Alder swamps should be cleared off, drained, and put into grass. The four great resources of our state are,—first, summer boarders; second, manufacturing; third, railroading; and fourth, farming. Why do the railroads oppose the farming interests? Why did they and the other corporations oppose the formation of the granges? Why did they coax and beg the farmers not to join the order? It is doing a good work; it is a school of agriculture, holding six or seven hundred meetings in the state yearly. The agricultural college and our agricultural meetings are a necessity for the agricultural education of our people.

This meeting together of farmers and discussing means and methods is of great value and interest to all.

J. O. Adams, secretary of the board of agriculture, offered a resolution favoring the establishment of a state experiment station; and another, favoring a law to protect farmers near cities and towns from foreigners who come here to work summers, and go back home winters, and help themselves to the products of our farms while here nights and Sundays.

Mr. Hills, of Plaistow, offered another to punish the selling of spurious and adulterated seeds.

Col. Shirley, of Goffstown, said the French Canadians did damage to our farms, and were careless of the property of others, and something like the tramp law was needed. If you order them off your premises they will get revenge by burning your buildings or lumber.

Mr. Rollins, of Bedford, wanted more security against the setting of fires by worthless people: it should be made a state prison offence.

Col. George W. Riddle, of Manchester, thought something more ought to be done to bring better stock into the state. The agricultural societies have about all they can do to pay their premiums, and there are now only three or four county societies which are on their feet; and soon, unless helped, they will all die out. The state of Massachusetts pays $600 to each county society. The state of New Jersey pays about $3,000 to its state society each year, for premiums on stock, and he thought this would be a good thing in this state. Encouragement should be offered for crops and farm stock, to improve them. He read the New Jersey act, and urged that members of the meeting use their influence to have a similar law passed in this state at the next June session of the legislature. The New Jersey act, with phraseology changed so as to apply to this state, reads as follows:

AN ACT TO PROMOTE THE AGRICULTURAL INTERESTS OF THE STATE OF NEW HAMPSHIRE.

Whereas, the agricultural and horticultural interests of this state need and deserve more public recognition and support, and hence are entitled to such material aid as will tend to stimulate and encourage the same;

and whereas, in consideration of the importance of such aid it is expedient to legislate by judicious care to foster this branch of our domestic economy by a system of proffered rewards that will incite a true spirit of generous and profitable rivalry among the tillers and producers of the soil; therefore,

1. *Be it enacted by the Senate and House of Representatives in General Court convened:* That the State Board of Agriculture shall annually appoint from its board two persons, and the directors of the New Hampshire State Agricultural Society shall in like manner appoint two persons from its board, State Grange of Patrons of Husbandry two, who, together with the governor of this state, shall constitute a committee to be designated and known as the "State Premium Committee."

2. *And be it enacted*, That it shall be the duty of the said state premium committee, upon its appointment annually, to meet and organize, and thereupon proceed to make up and arrange a list of premiums which shall, in the discretion of said committee, be most conducive to the development of the best agricultural and horticultural interests of the state; such premiums to be awarded to exhibitors at the next ensuing annual fair of the New Hampshire State Agricultural Society, and designated state premiums.

3. *And be it enacted*, That the said committee shall appoint competent judges from different parts of the state, whose duty it shall be to carefully examine the articles or products exhibited under the provisions of this act, and to adjudge and award the premiums specified in the aforesaid list upon the merits thereof, according to the classes or departments in said list prescribed, and in such action to be guided by the general rules and regulations of the said New Hampshire State Agricultural Society; and upon the conclusion of such award said judges shall make and submit a full and complete written report of all their said doings to said state premium committee.

4. *And be it enacted*, That it shall be the duty of the said committee, upon the receipt of the report of the said judges as aforesaid, to make up and submit the amount of the awards so reported to the governor of the state, who shall thereupon draw his warrant therefor upon the state treasurer, and said state treasurer shall pay the same out of any money in the treasury not otherwise appropriated, to the said committee, upon such warrants: *provided*, that the said amount shall not in any one year exceed the sum of three thousand dollars.

5. *And be it enacted*, That the appropriation for the purpose of carrying out the provisions of this act shall not exceed the aforesaid sum, as designated in section four herein; and this act shall take effect immediately.

The New Jersey premiums are for best stallion, $100; second, $50; brood mares, the same;—for cattle, herds, $100 and $50 each for herds of Shorthorns, Jerseys, Dutch, Ayrshires, and grades. Other premiums for stock and crops are in the same proportion.

Mr. Humphrey had great interest in this matter, and favored the state offering similar premiums to those offered by the state of New Jersey. The law provided for experts to act as judges, and this was a point worth considering. He would support the bill proposed. The railroads and other interests had a lobby at the legislature, and we should go there and work in our own interest if we wish to secure this legislation.

Mr. Goodell, of Antrim, said the times had changed, and manufacturers believed to-day that they needed farmers, and were aided by their prosperity. If the farmers would unite, they could carry through almost any reasonable measure they desired. He hoped the farmers would be better united than ever before, and secure the success to which they are entitled.

Mr. Lyman thought we might increase our crops and produce 10 per cent., and thus add largely to our resources.

Mr. Walker, of Concord, proposed that a law be passed to allow drainage, in the manner suggested by Mr. Lyman, through the land of another, or diverting water from its natural channel. The present law does not allow a person to drain his land, where it would take water from any mill privilege. Such a law had been introduced in the last legislature, and got as far as the judiciary committee of the senate, where it had its head wrung off.

Mr. Hills, of Plaistow, thought he should oppose a law allowing a neighbor to drain his swamp land through his field or garden. There were two sides to this question.

James Fellows, of Henniker, was strongly in favor of the pure seed law, but legislation for the farmer was difficult to obtain. Our congressmen are picked out for us by a few busy politicians, generally some aspiring lawyer; but they begin to see that the farmers are uniting, and they are learning to fear us. All are dependent upon the farmers for their food, and we are entitled to equal rights with all other classes in the country. We like the home market, provided and supplied by our manu-

facturing establishments, but syndicates and "corners" are to be deprecated, and that kind of speculation should have a stop put to it.

Mr. Ware, of Marblehead, Mass., said the $600 appropriation for each county agricultural society in Massachusetts was well expended, and had greatly built them up. If it had not been given to them, two thirds of them would not now be in existence. The majority of them are entirely dependent upon this bounty for their success.

Mr. Hills, of Plaistow, related several instances where farmers had been cheated by impure seeds, and he urged that the farmers should unite and insist on legislative protection in this direction. The bill referred to passed the house unanimously, but the senate killed it at the last session, and he intimated that it was done by a cheat. There is a great loss to farmers resulting from the sale of spurious seed.

Mr. Hersey, of Hingham, Mass., suggested that farmers buy their seed early, and test it, and, if it prove worthless, then they can try again. Better still: they should unite together and raise their own seed, one raising onion seed, another turnip seed, another clover seed, and so on, and then they are sure of good seed. We should raise all the seed we need, and save the expense of buying it. Cucumber seed can be raised by every one. All such seeds should be raised by farmers.

Mr. Humphrey thought the farmers should look out how the committees of the legislature are constituted. The railroads look out for their interests in this way, and we should do the same.

A resolution was proposed by J. O. Adams that the meeting select a committee of five to go before the legislature in connection with other agricultural committees, and secure the passage of laws for the promotion of the matters that had been under consideration:—to promote agricultural premiums; prevention of French-Canadian tramp spoliations; punishment of spurious seed selling; for more freedom for drainage of swamp lands; and the establishment of a state experiment station. This was unanimously adopted.

The committee was subsequently announced as follows: Hon. Moses Humphrey, Concord; Col. G. W. Riddle, Manchester;

Col. T. J. Whipple, Laconia; Hon. Geo. A. Wason, New Boston; and Hon. N. R. Perkins, of Jefferson.

In the second evening session, Wm. H. Hills, of Plaistow, was introduced as the speaker of the evening, who addressed the meeting most acceptably on the subject of "The small fruits." He complimented the city of Manchester in having so many fruit-trees.

The strawberry is the first fruit of the season, and lasts from June 1 to July 15; followed by the cherry, June 10 to July 20; raspberry, July 1 to August 5; currant, July to August; blackberry, July 20 to September 15; gooseberry, July to August; grape, August 20 to March 1; pear, July 20 to April; apple, July 20 to July, a full year; peach, July 25 to October; quince, September to December; and plum, July to October. These go around the whole season. They will lap over, and there need be no lack of fruit the entire season.

In growing the small fruits, first decide what you wish to do, whether to grow for the market or for home use. The market fruit is necessarily picked as soon as it is colored. It must be shipped as soon as it can be picked. Strawberries, for this purpose, must be of the hardy varieties. They must be attractive in color, of good size, and not too acid; but the taste of the market on that point is more acid than formerly. The Wilson is quite acid, and is very popular in the market. Firmness is of less consequence for the table, but is an essential in a market berry. The Crescent Seedling strawberry will remain four or five days on the vine after it is fit to pick. I learned this for the first time this year. For either purpose our berries should be hardy, healthy, and productive, and selected so as to extend the season as long as possible. The Crescent Seedling is early, medium, and late berry. The season may be regulated by the manner in which they are cultivated, whether they are given sunny or shady slopes. The Kentucky Seedling is no exception. The Glendale is not any later than anything else with me.

The selection of soil for the strawberry is not very material: they will adapt themselves to almost any soil. A good corn or potato soil will give you a good strawberry crop, if properly

manured. I would not plow over ten or twelve inches in depth. I would use irrigation, if possible; for they will use up a great deal of water with great profit. Make the land fine, as you would for an extra fine corn or potato crop. The best method for garden cultivation is the best for field cultivation. Make the plot long, for the convenient use of the cultivator. Plant out the rows three feet apart, if you have hills; but if matted rows, have them four feet apart, and let the runners grow. The row will then be about a foot wide, and all the runners will be pushed into place by the cultivator. For a cultivator, you want some implement that will not throw the dirt on the plants. This annoys the fruit-grower. I usually set them one foot apart in the row. If you want to cultivate with the hoe, they may be set one foot apart in the row, and the rows a foot and a half apart.

There are enough good berries from which to make a selection. I dislike the Glendale. It has a large hull, and is not late. I have twenty or thirty varieties. The Charles Downing is among the best. It is of good size, and very productive. The Sharpless will give a robin a good meal. These are among the largest I have. The Crescent will beat the world in productiveness, and grows and thrives whether well cared for or not. The flavor is better the longer it is kept on the vines. The Crystal City has proved a perfect failure with me, but I am going to try it again. The best success I have is with Miner's Prolific. They are the brightest colored of any berry. They are a white-tipped berry, and will color up in a day or two. The Wilson is a most productive berry. The Prouty has succeeded well, and fruited most abundantly, and the quality is excellent. The Monarch of the West requires high cultivation. The Windsor Chief has pleased me very much: it comes through the winter in fine shape. The Capt. Jack has not done well with me, and I have got but little return from it. The Bidwell and the Manchester are new candidates for public favor. I have not fruited either yet.

In purchasing, you should be sure and get plants perfect in their flower. They are not fertilized by the honey-bee. If the variety be imperfect, perfect flowering varieties should be set next to them, and they will be productive enough. When you

purchase plants, and they arrive, take them out of the box, but do not dash water on them and rot them; place them in a trench, and cover with earth till you get ready to set them. When you set, trim with shears, and clip the roots one third of their length; keep the sun from them, and set them out in a line; use a garden trowel, and not one in a hundred need be lost: they will grow well enough. When setting out in a dry time, pour water into the places for them, to supply them till they begin to throw out fresh roots. They should be frequently cultivated, and should be mulched after they are frozen into the ground, to keep them from thawing and freezing through the winter. Saw-dust, tan, and sea-grass make a good mulch, and nothing is required to be done with it, except pushing it off the plants in the spring, till you get your fruit off, and then move the mulching which you have left between the hills.

I think the best time to set is in the spring. Coarse swamp grass and swale hay may be used for mulching, but it must be cut early, or the seed will spring up from them. The flavor of native field strawberries is largely due to their being allowed to remain on the vines till thoroughly ripe. The land should be well fertilized, and in season. The fruit buds are formed in embryo in the fall, and the number of berries cannot be increased after this. To get good show fruit, cultivate in hills, and cut down all but the centre berry, and allow only one, or two at most, to perfect themselves. The following rules should be observed in strawberry cultivation:

1st. Select good soil.

2d. Give it a thorough mechanical preparation.

3d. Drain so that there will be no pools of water, especially in winter.

4th. Provide liberal fertilization.

5th. Make judicious selection of the varieties to be cultivated.

6th. Irrigate freely, especially in the time of a drouth.

7th. Keep all runners cut.

8th. Frequent fertilization after the fruiting season.

9th. Mulch them after the ground is frozen.

10th. Pack them honestly, and put your name in the bottom of the basket.

In answer to a question by Mr. Carr, of Haverhill, the speaker said grapes may be kept till March by packing them in leaves, or letting them dry into raisins. However, all varieties will not allow this. Further questions were asked and answered respecting fertilization, keeping, marketing, cutting runners, multiplying, etc.

The raising of blackberries was explained briefly. The Mammoth Cluster has given him the best satisfaction, and the Gregg is said to be even better than this. The suckers should be kept down just as weeds are. Strawberries, as an ordinary crop, will produce 100 bushels to the acre; raspberries will not produce quite so much.

An informal talk followed, and with resolutions of thanks to the speakers and the reporters, and the customary resolutions to the railroads and the hotels for courtesies tendered to the members of the meeting, it adjourned *sine die* at 9 o'clock.

MEETING AT CLAREMONT.

A meeting of two days' continuance was held in the town hall, Claremont. The report is abridged from the account given in the Claremont papers.

D. T. Chase, Esq., presided, and opened the proceedings by some well-timed suggestions. A pastoral song was finely rendered by a quartette composed of Messrs. Perley and Haskell, Mrs. Geo. H. Baker and Miss Nettie Clark. The secretary of the board, J. O. Adams, read an instructive paper on the fruitful subject of "Weeds." The loss and gain, and particularly the former, resulting from their presence in the farmer's fields, were set forth in clear colors, and elicited considerable discussion.

G. K. Harvey, member of the board for Cheshire county, gave a very pleasant entertainment on the Silo and Ensilage question, in which the different modes of filling and packing, and the effect of properly cured ensilage fed to different kinds of stock, were fully explained. Many questions were proposed by those present, and answered by Mr. Harvey, and commented on by gentlemen in the audience, the conclusion appearing to be that at no distant day the silo would be deemed as much of a necessity as is the barn.

At the evening session, E. M. Goodwin, member of the Vermont agricultural board, read a very carefully prepared paper on grass-culture. The grass crop should be made the paramount object of the farmer. To successfully produce it, the land should be turned in autumn, then it must be finely pulverized in spring, as soon as it is in proper condition, and different varieties of grass seeds should be sowed and brushed or rolled in. He thoroughly condemned the practice of feeding the mowing lands spring or fall. He who did it could not succeed. As a fertilizer, muriate of potash and ground bones, five hundred pounds per acre, had paid well. For planting, he had used per acre one barrel of ground bone and seven bushels of wood-ashes, well mixed, and dampened with about eight or ten gallons of water, then put up in barrels till properly heated, and sown broadcast. He believed that hundreds of farms could easily be made to produce double, or even triple, the amount that they do under present culture. Mr. Goodwin generally began his haying about the 25th of June, but made it a point never to cut grass when wet. It must stand until dry, if until noon. When well wilted, it should be put in cock, and not opened until placed in the barn. Experiments had abundantly shown that hay thus cured, and kept in tight barns, would not hurt if put in very green. In answer to a question, Mr. Goodwin said top-dressing on grass had not given him as good results as the use of the same fertilizers had done in course of cultivation. On dry soil, seeding might be profitably done in the fall. The subject drew out much discussion, the New Hampshire members and others participating.

In answer to a question, Mr. J. L. Gerrish said the cause of timothy grass giving place to white-top was a lack of phosphoric acid in the soil. Many varieties, including the meadow grasses, were discussed. Messrs. Harvey and Humphrey doubted the propriety of using the quantity of seed recommended by Mr. Goodwin. They thought it would largely overstock the land.

Mr. Hills, member for Rockingham county, said,—"In seeding, we must consider the soil: dry land requires much more seed than moist land." On dry land he would sow clover and red-top, and favored seeding in the fall. The entire evening session was devoted to this subject.

On the second morning session, the chairman of the board, Hon. Moses Humphrey, of Concord, discussed corn-culture. We can only glance at a few points presented by this distinguished agriculturist, although every word he uttered should have been heard and well digested by every farmer in the state. Corn was one of our most important productions. Statistics bearing on the subject were given. He thought corn could be produced by the use of chemicals, without having recourse to barn-yard manures. He thought frequent manipulation of the soil good policy, though crowding the growth too fast may prevent the proper putting out of ears. In connection with this idea root-pruning was discussed. No farmer could succeed to the full extent without the use of phosphates in some form. He spread this article broadcast, and put a small quantity in the hill. By proper cultivation corn could and had been grown fifty years in succession on the same ground. He believed in planting much closer than was generally practised. He planted two feet apart one way and three feet apart the other way, and only rowed one way. This close planting shaded the roots, protecting them from heat and drouth, and induced more full earing of the crop. In confirmation of this fact, he instanced the lack of ears on outside rows. He generally realized two ears of sound corn on a stalk. Another important consideration in corn-culture was the feeding value of the fodder, which, grown in this way and properly cured, was nearly or quite equal to the same area in good grass. He allowed his fodder to dry sufficiently in the field, when it was stowed away in the barn. Corn-fodder lost much of its value by being dried too much.

A somewhat general discussion followed Mr. H.'s address. Mr. Gerrish did not use green manure under corn. Chemicals he regarded much better and cheaper. Mr. F. P. Smith, of Claremont, presented statistics showing that 1,375 tons of corn and other foreign feed had been sold within the year in Claremont; also 7,000 barrels of flour and 8,000 tons of coal had been sold in town in the same time,—arguing the necessity of larger production, that our market might be supplied from home culture, and thus retain the money among our own people. Mr. D. T. Chase said,—"More corn is raised in Claremont now than there was fifty years ago, but the great increase of population created the enlarged demand."

Hiram Parker, member of the board for Sullivan county, suggested that if the foreign grain was properly fed, and to proper stock, there could be no loss by its purchase; if fed to old, unproductive horses, or to cows that would not return more than four pounds of butter per week, a great loss must follow. We do not farm for the pleasure of it, therefore we must feed our grain to such stock and in such a way as to make it pay.

In the afternoon Mr. Hills spoke on fruit-culture. He hardly knew what branch of the subject to take up, so numerous were the phases it presented. The wild or native apple never improved itself. Wherever found it is the same that it had been ages ago, but by transplanting to the garden and cultivating, it becomes larger and better; the seed from this again cultivated is again improved, and so on. It seldom happens that the seeds reproduce the same as the apple from which they come; hence, by seed-planting and making selections from the product, choice fruits are obtained. His way had been to plant the seeds, and bud with choice varieties when the plants were small. He budded at the ground. Every man might have the best fruit on his table every day. It was not necessary that farmers should use such as was hardly fit to grind up for cider. Near Boston, where land was worth $1,000 per acre, the owners get $1,000 per year profit from it in growing fruit, and that found on many tables far back in the country is brought from Boston and its vicinity. This was all wrong. It could be raised much cheaper here, and cultivation through six or seven generations from the native tree would give a choice fruit. We could hasten the maturity of fruit by grafting. The peach had been produced from the seed in the short space of eighteen months. Mr. H. demonstrated the mode of budding by taking a proper sized branch of the apple and setting a bud in the manner practised in the production of fruit, which drew a crowd around him to witness the operation.

The flowering of plants and fruits was brought under review. Their sexuality had been known about fifty years. He spoke of the production of the Hovey strawberry. Different varieties are produced by setting different plants side by side, so as to fertilize the one from the pollen of the other, producing a differ-

ent variety from either. But imperfection was often the result of this kind of cultivation. The two important parts of the flower, viz., the pistil and the stamen, were described, and the part each performed in reproduction. These hybridized plants were often found with the pistil developed, but wanting the stamen. In this case they could never produce fruit unless grown near some perfect variety that should fertilize the flower. Some varieties would become so fertilized at a distance of twenty feet. Modes of propagating flowering plants of different species were discussed and fully explained. Mr. Hills expressed the opinion that the peach, under proper cultivation, could be successfully grown in Claremont. The wild or native variety was best to start with, and should be grown on the poorest ground, without fertilizers. Let its growth be slow, and the fibre would be hard and enduring. It was the rapid growth that winter-killed. The grape was considered at some length. We had made and were making great improvement in grape-culture. The manner of propagating the vine and producing new varieties was discussed. The Concord had been the parent of many excellent varieties, also Moore's Early. He didn't deem it profitable to graft the grape. He could produce fifty new vines more easily than he could graft one. He would take a shoot on a growing vine, prepare a small trench and lay it in, and press the earth closely on it, adopting some simple device to hold it in place. Each bud on the shoot would put forth rootlets, and when sufficiently advanced, cut them from the parent stalk, and cut the different sections apart, and they were ready for transplanting. The rose could be propagated in the same way. This was the rule. But the white rose being very delicate, it might be doubtful whether it could be propagated in this way.

A general discussion followed, in which many of Nature's vagaries were considered. Mr. S. Wood, of Claremont, knew apple-trees on a farm in Rockingham, Vt., that bore in the same apple both varieties of sweet and sour. Of this Mr. Hills expressed doubts with considerable vehemence, asserting its utter impossibility.

So far as the board is concerned the meeting was an abundant success; but the advantages to be derived in a large, wealthy, and one of the best agricultural towns in the state from submit-

ting the results of years of experience, of laborious study, and of expensive experiments, when farmers stand listlessly about street corners, nor deign to notice its presence, may be deemed somewhat problematical. This board has cost the tax-payers of the state more than $50,000, and it is believed that the outlay has yielded liberal returns; but, like Joshua of old, it needs to have its hands held up while the fight goes on with the heathen.

MEETING AT NEWPORT.*

Newport farmers expect either snow or rain when they have a meeting of the board appointed. The usual disappointment occurred again. The storm was so severe that it was thought there would be no meeting, but a few good farmers assembled. The Arion male quartette sung a piece acceptably, to open the meeting. The meeting was called to order by Mr. Whitney. Mr. Parker, member from Sullivan county, after a few brief remarks, introduced Secretary Adams, who spoke at length on feeding animals. He said, Nature is very wise in her adaptations. The horse, that was made for travel, has but one stomach, and large, active intestines, which make it possible to digest its food while in service, while the ox is differently constituted. He, being of slow locomotion, can take a hasty meal, partly chewed, and carry it along with him at his slow pace, and digest it as a ruminant at his leisure. The stomach of the ox is fourfold. The stomach of the sheep is somewhat similar. Judgment must be used in feeding differently constituted animals, according to their work and their ability for digestion and assimilation. The hog, although it does not have a large stomach, can eat and lie down. If kept at work on the manure-heap it would require food in proportion to its work. Did not think a fattening hog should be required to work very hard, but should have close but clean quarters.

He stated at length the principles of combining such foods as would meet the combustion and flesh-forming necessities without loss in feeding any one element to excess. He referred to the German feeding experiments, which are of some value to farm-

*Reported for the *People and Patriot* by Mr. Gerrish, as was also the Boscawen meeting.

ers, and spoke very highly of the practical work of Prof. J. W. Sanborn, formerly of our college farm, now professor of agriculture in the Missouri Agricultural College, and secretary of their board of agriculture, who, with the education of the common schools of New Hampshire and a term or two at an academy, has done more in making practical feeding experiments than any man in America.

Mr. Adams spoke of milk as a perfect food for young animals. Young animals, comparatively, were the most profitable to feed. For young animals, when past the milk feed, give swale hay, clover, and grain, giving more grain and concentrated food as the animal begins to prepare for the butcher or to give milk. He believed it economy to feed grain enough winters to keep the young animals growing. Cold weather makes it necessary to feed more; therefore keep the stable warm. It had been proved to be good economy. Purchasing feeds to keep the young animals thrifty in winter would help bring up the farm. It is estimated that if we sell a ton of hay we carry off $6.50 of value, from the manurial standpoint. If we sell we must buy something back, or we sell real estate. It might pay in some cases to sell good hay and return poor fodder and grain.

Mr. Parker, of the board, said if we bought feed we must not give it to some old cow that would not make more than two pounds of butter a week, or to an old horse. We must get a profit besides this manure.

Mr. Shattuck, a Newport man, who had opened a small silo, had brought a sample of ensilage. He said this was his first year, and he declined an opinion—it was not time—but would state the facts about commencing to feed. He put in three fourths of an acre, estimated at ten tons. On opening it some of his cattle took it readily, while others were inclined to turn up their noses. All ate it well when they had once learned. One cow in particular ate about three pecks of it, and refused it thereafter for three days, when she decided to eat a peck a day or more. He raised his corn cheaply, and half of it got a frost before it was ensilaged. He was feeding a section from top to bottom, and noticed no difference between the frosted and that not frozen. His silo only cost the matter of $25, and would not

break him if not a success. It was above ground, in the barn-cellar, 7½ x 13 feet, with framed sills at the bottom, and 3 x 6 scantling at the sides, double boarded inside, and boarded once outside the joists, the space being filled with sawdust. Had not yet fed it to sheep. Was feeding hay, oat-straw, and meal with it, excepting that his young stock did not get much grain.

On invitation of the secretary, Mr. Gerrish, of Webster, spoke upon the necessity for better stock in New Hampshire; that it could be had without large individual expense by the judicious purchase of thoroughbred male animals. When manufacturing on Sugar river didn't pay, they shut down the mills and put in better machinery. Our stock is the farmer's machine; his money and brains the engine with which to run it.

If the cattle that we New Hampshire farmers possess on the average do not manufacture butter, beef, pork, speed, work, wool, and mutton to a profit, let us shut down and replace them with those that can.

Towards the close of the meeting, which was a profitable one, the discussion became general. The subjects—the stomach of the horse; the effect of cotton-seed meal and shorts. Both sides of the latter were discussed, and no conclusion positively arrived at. The feeding of the horse was spoken upon by Messrs. Eastwood, Quimby, Wright, Bowers, members of the board, and others. The summing up was about like this: Oats for drivers, cracked-corn for workers, most of hay in morning when fresh, and grain at night. Never water immediately after eating.

With the ensilage on the table were laid some samples of a seedling of the Jackson White potato, five years from the seed ball, raised by S. A. Tenney, of Newport.

MEETING AT BOSCAWEN.

The members of the Boscawen farmers' club, together with the State Board of Agriculture, held a large and successful meeting at the town hall, Messrs. Adams, Hills, and Goodell, of the board, being present. The forenoon had been assigned to Mr. Humphrey, but he not putting in an appearance, after some delay Mr. Hills took the floor, and gave a rambling talk on pota-

toes. He spoke without notes. Thought if he said anything that was true it would probably not be very new; and the chances were if he said anything new it might not be true. Every man has his own way of doing things, even in raising potatoes. Some one had lately said that the new varieties, like the Early Rose, would not produce seed-balls because they had been degenerated by cutting the seed so fine. He did not believe there was any proof of that, although it was a fact that he had never seen a seed-ball on the Early Rose. He once raised over four bushels from two pounds of seed, which of course made it necessary to have the seed cut very fine. It did not weaken the Baldwin apples to propagate by budding, and a potato eye is similar to the bud of a fruit-tree. No doubt the method used in cultivating and producing new varieties essentially removed them far from their original condition. He thought it was this that caused them to become unproductive in seed-balls, as, the farther you improve domestic cattle the less prolific they become. The same rule holds true with onions, as well as potatoes; the scullion, if set out, will bear an abundance of seed—much more than will be produced from a perfectly-shaped one. Florists had bred the aster so far from the original that it was double, and the petals so multiplied that there was little room for seed. We hear of many seedlings of the Early Rose. These must be produced by cross-fertilization, which is the only true way to originate new varieties of fruit, flowers, or vegetables.

Mr. Hills's method of raising potatoes was to plow deep, spread the manure on the surface, and thoroughly incorporate with the soil by the use of a disc harrow; then strew special fertilizers on the furrow, and plant in drills. Would never have more than three eyes in a piece if it could be avoided; in fact, would prefer to have but one stalk to the hill. In planting thus the special fertilizer would be sufficiently mixed with the soil in covering. Would commence to harrow as soon as they break the ground, with a Thomas harrow or some other suitable implement, which saves once hoeing.

It is a good plan to expose the seed potatoes for a time to light and air before cutting. Would be cautious about cutting long before using unless they could be carefully watched, as, if spread out thin, they might dry too much; while, on the other

hand, if kept very long in barrels they would heat and destroy the vitality of many of the pieces. He had paid dearly for this knowledge, and was obliged to plant cabbages in the missing hills. If the case was thoroughly understood, the pieces could be spread out and covered lightly with horse manure.

Questions were asked by Mr. Osgood, of Canterbury, and others, regarding the rot and scab. Mr. Hills replied that he usually mixed plaster with his special fertilizer, which was equivalent to treating the scab (which some had supposed to be fungus) to sulphur. Some one had tried shorts in the hill, while others use quicklime. Chemical fertilizers would make healthy looking potatoes.

Col. Clough gave his experience in applying manure. Had found, by practice, that it was safe to haul out manure and spread in winter, and plow under in spring.

F. B. Sawyer, of Webster, thought if rains fell after spreading the manure the result would be good. Another Webster farmer had lately spread out thirty-two horse loads on an acre, intending to plow it under, with what grass will grow before the 20th of June next, and plant with potatoes. This was on comparatively level land.

I. N. Sawyer, of Salisbury, would go further, and spread in winter, even though on side hill. He had seen considerable in one paper in this state on the subject lately. His experience would bear him out in spreading broadcast, in late autumn or winter, on quite steep side hill, either for corn or potatoes. This was done on his farm where it was so steep he could barely drive a mowing-machine.

Secretary Adams had raised healthy potatoes both with Bradley's XL and special potato fertilizer.

At this point the questions and discussions took a general turn. The main points brought out were in proof of the desirableness of thorough and long-continued cultivation for successful corn-culture, especially in dry seasons.

The meeting was opened in the afternoon by Mr. Goodell, of Antrim, member of the board, who, after complimenting the roast turkey provided by the farmers' club, said if farmers would study economy and the details of business as closely as manu-

facturers, few if any would fail. Only a very small proportion did now, as compared with merchandising men. He believed a great saving might be made in the cost of curing hay. Ten years ago John Johnson cut his hay in good nice weather, in June and July, and stored it the same day if the weather was fine. He had tried this method, filling up the scaffold or bay, and covering it with a layer of poor hay or straw. The weather must be fine and the ground comparatively dry when the grass is cut, and it should not be mowed until the dew is off. Hay put in thus would be sweet and nice, excepting perhaps an inch at the bottom and five or six inches on top. It is necessary to *fill* the scaffold or bay at once, and then let it alone. It will probably be quite wet on top in a few days. One advantage of putting in hay the day on which it is cut is, that it is easier to judge of the weather for one day than for two. It is a great saving of labor of handling. In reply to a question, he said that this was particularly a good method for clover, the heads coming out red and fresh when fed out.

Mr. I. N. Sawyer had tried this method; did not succeed as well with poorer hay that had a mixture of pollypod brake in it, as that turned black. Mr. Osgood tried it once with good success. Mr. Cate, of Boscawen, an observing farmer, had tried this method of harvesting hay with success.

Mr. Goodell resumed: I do not speak encouragingly of those farmers who adhere too closely to the old customs, merely because of habit in the matter. He then said we were living in a fast age, and continued giving an account of his experience in the use of ensilage and the method of building a silo, which we forbear to repeat at this time.

After Mr. Goodell closed, and questions had been asked and answered, Mr. Hills of the board gave an interesting essay on soiling, which was comprehensive, and would interest those readers who live near the villages and large cities. As it would be useless to give any synopsis of this paper, we will not enter the subject at all in this already lengthy report.

Mr. Hills did good service at the Boscawen meeting. He ought to be kept on the board for a long time, if his life is spared, in our opinion. Few men in the state, directly and legitimately connected with the subject of agriculture, have that

rare versatility of mind, large fund of experience, and humorous and happy expression, that are combined in the member from Plaistow.

In the evening, knowing the literary treat that was in store, not only farmers but the citizens and people from out of town, including a large number of ladies, assembled until the hall was full.

Hon. Joseph B. Walker of Concord, and D. H. Goodell of Antrim, occupied the entire evening. Mr. Walker's subject was "Reminiscences of European travel." Mr. Goodell's subject was "New Hampshire homes." Both gentlemen (inspired by the large and intelligent audience) were very interesting in their remarks, both speaking without notes.

After a few brief remarks by Mr. Webster, president of the farmer's club, and the usual exchange of compliments, the meeting dissolved.

MEETING AT JAFFREY.*

The farmers' meeting at Union Hall, East Jaffrey, on Thursday, December 28, under the auspices of the New Hampshire Board of Agriculture, was attended in the afternoon by about fifty persons, mostly men. There were present, of the board, Secretary J. O. Adams, W. H. Hills of Plaistow, Geo. K. Harvey of Surry, and D. H. Goodell of Antrim. The principal topic of discussion was Silos and Ensilage. Mr. Goodell, who is the owner of a large silo of the capacity of 360 tons, gave an interesting account of his experience in this line, and of some experiments which he had made to test the value of ensilage as fodder. He believes that fifty tons of corn-fodder suitable for ensilage can be raised per acre, but estimates from twenty-five to thirty tons per acre as about the average yield. This is worth as much for feed for cattle or sheep as eight tons of English hay, and while it costs $7.50 per ton to cut, cure, and store the hay, with proper tools and machinery a ton of ensilage may be cut and packed in the silo at an expense of only $2.50 per ton, with no risk of injury by storms as is the case with hay.

* Reported for the Peterborough *Transcript*, by the editor.

He commenced feeding his cattle at the barn in September of 1881, giving them good English hay, but they did not show a gain until he opened his silo some time in November and began to feed ensilage. This was especially noticeable in the case of a pair of oxen which he continued to feed upon ensilage until the next March, when he sold them for beef, and he believed them to be the fattest and best he ever saw. He considers it remarkably well adapted to milch cows, increasing the flow of milk to a considerable extent, as he most satisfactorily proved by several experiments. It also proves well in making butter, increasing the quantity and in no way impairing the quality.

Another advantage claimed for the silo is, that it requires less barn-room, and therefore more stock can be kept in the same space. He also stated that silos could be constructed inside of barns, thereby saving the expense of a roof, at a cost of one dollar for each ton of capacity, by making a cement bottom, and using boards or plank lined with tarred paper, to exclude the air, for the sides.

Mr. Harvey said he had built a silo of fifty or sixty tons' capacity, of the above description, at an expense of forty-five dollars, which preserved the ensilage in good condition, and served all practical purposes. He also stated that the small farmers need the advantages of the silo more than the large ones, because in this way they can double the amount of stock kept on the farm without additional expense.

Mr. Hills is somewhat skeptical on the ensilage question. He does n't believe that corn-fodder is improved by ensilaging it; allows that it may be more palatable to cattle, but not more valuable. He had heard it said that cattle kept in the barn continually, summer and winter, and fed upon dry feed, would in time refuse green feed. He has two cows that have not been in a pasture for six years, yet they will eat green fodder as readily as any animal. He also thinks that green fodder that has lain several days after being cut, and become thoroughly wilted, is at least as good if not better than when fed fresh.

Dexter Derby, Esq., of Dublin, says he believes three quarts of meal scalded is worth as much for feeding cattle or hogs as four quarts raw.

Mr. Hills said he did not believe sour food of any kind is so

well relished or so nutritious as that which is fresh and sweet, neither for hogs nor cattle.

Secretary Adams believes that ensilaging certain crops is the best and most profitable for several reasons. It creates more animal heat, is easier harvested, there being no risk on account of weather, a foul or even a wet day being as good as any for cutting and preparing for the silo: the harvesting can be done in much less time, and it requires a much less space for storage. For the above and other reasons he considers the silo an advantage to the common farmer, even if there is no special increase in the value of the crops by ensilaging over the ordinary way. But, says he, don't get excited over it, thinking you will get suddenly rich by building a silo. Watch the progress and development of this theory through inexpensive experiments. Go slowly, no faster than you can go safely. He believes that a cheap and complete silo will yet be constructed, one that every farmer can afford to build.

Dr. O. H. Bradley said that in his judgment one important point in the consideration of the ensilage question had not yet been discussed, and that was the digestibility of the ensilage as compared with that of dry hay and corn-fodder. By the process of fermentation which ensilage undergoes, the starchy matter is changed into a more digestible material; hence more of the food is appropriated to the growth and condition of the animal, and consequently less food will accomplish the same result by this method. He also stated his belief that most people overfeed their animals, especially their horses. It is well known that the doctor always keeps his horses in fine condition. He says he never had a sick horse in his stable, and while some of his neighbors' horses are poor on six quarts of meal per day and with no more work than his own, his are kept almost hog fat on a feed of three quarts per day and hay accordingly. Here is a hint for horse-owners, at least, to act upon. Our own experience corresponds with that of Dr. Bradley. It is not only a waste of material, but a positive injury to the animal, to crowd more into its stomach than it can properly digest. It will soon cause a derangement of the digestive organs, and bring on disease.

In reply to Dr. Bradley's allusion to the fermentation of en-

silage, Mr. Hills said that fermentation was the first step in the progess of decay, and that decay means loss. That is, the moment that anything commences to decay it begins to lose something. From this it will be seen that Mr. Hills is skeptical as to the great value of ensilage over dry fodder; still he is not quite sure that it will not prove in some way beneficial to the general farmer.

At this point the meeting adjourned to 6:30 P. M. Not being present at the evening session, we are unable to give a detailed report of the exercises. We are informed, however, that there was an increased attendance, and that the principal topic of discussion was the culture of small fruits, which was made very interesting, and we trust profitable, by Mr. Hills.

In addition to the talk by Mr. Hills in the evening, the secretary discussed special fertilizers, Mr. Harvey had more to say on the silo, and Mr. Goodell made an eloquent speech on "The strong men of New Hampshire."

MEETING AT LYME.*

The board held meetings at Lyme on the 24th and 25th of January. There were present of the board, Mr. Humphrey, chairman, Mr. J. E. Carr of Haverhill, Mr. Goodell of Antrim, and Mr. J. O. Adams, secretary of the board, who is also lecturer before the agricultural college at Hanover,—Mr. Carr presiding.

The meeting was opened at two o'clock Wednesday afternoon, and the afternoon was occupied by the discussion of the question of manures and fertilizers, Mr. Adams leading, and was followed by Mr. H. L. Fitch, Col. Beal, Dr. Kingsbury, Dea. Grant, and others.

In the evening, Prof. Scott, of the agricultural college, ably advocated agricultural education, and Mr. Walker, of Concord, discussed the question of the growing of grasses, and insisted that we should not be satisfied with less than two tons to the acre. Both Prof. Scott and Mr. Walker commanded the attention of large and intelligent audiences.

Thursday forenoon Mayor Humphrey occupied some two

* From a Report by A. McLean, Esq.

hours in discussing the question of corn-raising in New England, and insists that with proper skill and perseverance we can produce our own corn, and thereby save a vast amount of money at home that now goes abroad. He claims that he can raise corn at a cost not to exceed forty cents the bushel. He was interrogated, by Mr. Fitch, Dea. Churchill, I. N. Perkins, John L. Norris, and Elisha P. Snow.

In the afternoon, Mr. Secretary Adams gave one of his talks on the subject of dairying. He introduced the subject by saying that it required the greatest gentleness, neatness, and delicacy, beginning with the treatment of the cow and extending through the whole process, to make gilt-edged butter. He particularly emphasized the necessity of gentleness towards the cow and neatness in milking, although there is no occasion of impressing the necessity of neatness upon our women in the performance of their part of the work, for they are proverbially neat, and that if he thought otherwise he would not dare to say so. That they were all neat he knew from personal observation, for he had kept school and boarded around; but it was a a very delicate and nice thing to make gilt-edged butter, and to do it successfully it is necessary to begin at the barn and have everthing neat and cleanly there; would not permit of anything of an odorous nature within smell of the cows, as he believed it would impregnate both the milk and the butter; that to get the best results from a cow there should be a reciprocal affection between her and the milker, and that no violent language should be used towards her; that the pasturage should be gently sloping, with clear, running water, and free from swamps and bogs and all other odorous exhalations. For winter forage preferred rather early cut hay, a little less matured than is demanded for working oxen and horses; that a majority of gilt-edged butter makers prefer home grown corn meal to shorts, as shorts make the butter crumbly.

As respects the breed of cows: For butter, prefers the Jersey or the Guernsey, and next, the Devon, and would use all of one breed, as it is found that the cream of some breeds is more quickly agitated into butter than others; and as it is an injury to the butter to churn it after it has "come," the whole batch is to a certain extent injured. For cheese, the Ayrshires or

Dutch or Holstein and the Shorthorns, as these breeds yield milk richer in the qualities necessary to the production of cheese. Would have the cows milked expeditiously, and referred to a distinguished dairyman of New Hampshire who requires his men to milk twelve cows each in one hour. That better butter is obtained with thirty minutes of churning than a less time. This, of course, is only a brief abstract of what he said, and many useful hints and suggestions are necessarily omitted.

Mr. Adams was followed by Mr. Goodell, who spoke on the subject of ensilage; and he spoke from experience, having a silo of his own. He said we lived in an age of improvements; that only a little time back, and the student pursued his studies by the light of a tallow candle, and our transportation over the country was by horse-power,—but these things are different now; that oil comes gushing out of the earth at man's bidding to take the place of the candle, and steam has supplanted the horse in the transportation of merchandise and passengers; that there is no reason why equally surprising discoveries and improvements should not be made in the department of agriculture; that the farmers of New England have been accustomed to speak of their leading crop as the hay crop, but instead he would call it the forage crop, embracing all substitutes for hay under the general term forage; that he believed the introduction of the silo would greatly increase the capacity of the farm for keeping stock, and, as a consequence, in the same proportion increase the net income. He, at considerable length, detailed his experience with his silo. In 1880 (I think it was) he built a silo and put in about 180 tons of ensilage. After it was in he concluded he had got to have more stock, then having 38 head of neat cattle (cows) and four horses—considered that he had just about enough fodder, exclusive of his ensilage, to keep his stock through the winter; that he bought of cows, farrow and otherwise, 20 head more, and wintered them all out, except two or three dry cows sold in February for beef, and that they all went out in fine condition, and yet were fed only the same quantity of meal per head that he was accustomed to feed when feeding dry fodder wholly; and that after turning his stock to grass he found himself with 20 tons of his best English hay on hand, so that instead of wintering 38 head of cattle and four

horses, he had wintered 58 head, and had this quantity of hay left. That his stock was mostly cows, and he sold his milk; and he gave the results of an experiment made by him, as to the milk-producing qualities of ensilage as compared with hay. That he took one cow and fed her three days on ensilage with the usual ration of cotton-seed meal, then measured one day's yield of milk and had nine quarts; then fed three days with two rations of hay and one of ensilage with same quantity of cotton-seed meal, and found the milk yield to be seven quarts; and then three days on hay alone, with same quantity of cotton-seed meal, and found the yield of milk to be six quarts, demonstrating that ensilage greatly promotes the yield of milk; and as to the quality of the milk, he said his customers, when he came to feed ensilage to his cows, commended the milk as the best they had ever had. He believes it not best to put cattle on ensilage or any other fodder wholly, as they, after a while, cloy of it and do not do so well; that his practice is to feed two rations a day of ensilage and one light feed of hay. Does not consider ensilage good for horses or calves. There were no inquiries made about feeding it to sheep, and nothing was said about it. He was interrogated by Mr. Fitch, Dr. Kingsbury, S. K. Berry, and several other gentlemen in respect to details, and responded.

Of course this is only a brief abstract of what he said, and we do not pretend to have touched upon every point discussed, as it would occupy too much space. The weather was fine and the attendance good. The farmers of Lyme, and there are many good ones there, appeared to be much interested in the discussions.

Other meetings were held in various sections of the state. In Coös county there were four meetings conducted by Mr. DeMeritte and the secretary. There were two in Grafton county, not named in these reports, one at Campton and one at North Haverhill. At the latter was a large gathering, the meeting continuing two full days. Dr. Kingsbury was present, and made a good practical talk on farm management. Mr. Walker gave an able lecture on forestry, which appears in this volume more fully than when first delivered. The great feature of this

meeting was the large number of questions proposed through the question-box, which were fully answered by parties present. The secretary and Mr. Hills were present, and took an active part in the meeting. Mr. Carr presided.

Meetings were held at Centre Harbor, Melvin Village in Tuftonborough, Surry, Marlow, Tilton, and elsewhere. As the reports made cover the leading topics discussed, the secretary omits extended notices, which would be but repetitions of other meetings.

In addition to the meetings named, the board joined with the Patrons of Husbandry in their annual meeting at the Wiers, and Messrs. Humphrey, Adams, and Goodell each occupied a half hour in addressing the meeting.

Members generally attended the state fair at Concord, and most of the members were present at fairs in their own counties.

Messrs. Hills, Carr, and Adams attended a meeting of the Vermont Board at Bradford, and engaged in the discussions before the meeting, especially those on manures and fruit-growing.

ADDRESSES AND PAPERS

GIVEN BEFORE THE

BOARD OF AGRICULTURE.

THE FORESTS OF NEW HAMPSHIRE.

BY JOSEPH B. WALKER, OF CONCORD.

PRESENT CONDITION OF OUR FORESTS.

When our English ancestors made their first settlement upon the eastern borders of this state, it was everywhere covered with a dense forest. This, interrupted only by the water's surfaces, with which we are all familiar, and a few mountain summits above the line of arboreal vegetation, extended everywhere—from the Piscataqua to the Connecticut, and from the mouth of the Merrimack to Indian Stream. For generations which we cannot number, as they kept no records, it had been the heritage of the red men, and in their possession. Living and dying in its shadows, they never wasted it, or diminished its area.

But the white man, unlike the Indian, could not live in the woods. The civilization which he brought to his new home required sunlight and an uncovered soil. As a consequence the forest began, immediately upon his advent, to recede from Strawberry Bank and Dover Point, and subsequently, as population advanced inward, the woods gave place to other clearings, which have been enlarging ever since.*

*The following sketch of the first period of lumbering in New Hampshire, by Joseph Barnard, Esq., of Hopkinton, published a few months since in the Concord *Monitor*, is interesting as a graphic sketch of early denudation in this state:

"Before American independence, the king of Great Britain sent his agents through this state, who marked a large number of trees of sufficient size to make masts for 74-gun ships of war, with the broad arrow (thus, A) cut deep into the bark, about four feet in length. No one was allowed to meddle with the marked trees under a heavy penalty. There were two in the mast swamp in Boscawen, and one on the farm of the late Isaiah Webber, in this town. One of the former and the latter were cut before the Revolutionary war. It was said by old people that a pair of six-feet cattle could be turned on the stump without stepping off, of the one cut in the mast swamp. It took twenty-five yoke of oxen to draw the mast to the river. The other one had the top broken

In the absence of authoritative statistics, it is impossible to state with accuracy our present forest area. Careful observers, whose attention has been called to the subject, think that about forty per cent. of the state's surface is at this time covered with woods; that of this portion one fourth is of primeval growth, and three fourths of growths more recent, varying in age from that of the sprouts of a single season to the mature trees of a generation. In other words, we have yet in New Hampshire

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off by the wind, and was hollow. It was about sixty feet high, and a fine specimen of the old pine. A few years ago it was cut by some coon hunters. It was about five feet in diameter twelve feet from the ground, and was always known as the 'King' tree.

"During the early period of settlements, masts were taken from this section of the state to the seaport. Large numbers were taken from the mast swamp above mentioned, and were drawn to the mast-yard on the bank of the Contoocook river, near the Mast Yard station on the Concord & Claremont Railroad: hence its name. A large number of men came up winters from the lower towns, and built log-camps for themselves and ox-teams. Within my remembrance the spot was plainly marked where these camps had rotted down, and the old pine stump was still there in the centre of the men's camp, with the top scooped out for the barrel of rum to set in.

"Soon after this saw-mills were erected on the small streams in different parts of the town to saw lumber to build farm buildings, and sell to the village people to build up the villages. These mills had the up-and-down saw, which would cut about 2,000 feet a day. I find, by my grandfather's old mill account, dating a hundred years back, that boards were sawed at his mill, and drawn by ox-teams from here to Garvin's falls. One of the first settlers drove mill-logs for several years from two miles above Contoocook to Newburyport, and gained a good property by the operation. The early settlers employed more help than we do at the present time. After harvesting was over, the surplus help went to the woods, and worked in the winter months, splitting and shaving short and long shingles and clapboards from pine trees; also, white oak, ash, and chestnut into barrel-staves and headings, and red oak into shook-staves. Others cut, split, and shaved hoop-poles. Most of these men were experts in the business. Those who made shingles were called shingle-weavers. They would frequently box into a tree, and take out a large chip: if it proved to be cross-grained, or winding, it was rejected. I have cut many of these rejected trees in lumbering. I once saw one of these shingle-weavers at work, splitting his shingles so near the pattern that they needed but very little shaving. The shingles were bound together by split pieces of wood, called binders, 200 in a bunch. The clapboards were tied in bunches of 25 with withes. In this way they were transported to market by ox-teams, and exchanged for such goods as were wanted by the farmers, sometimes receiving part money for pay. The white oak, ash, and chestnut staves were mostly worked into barrels by coopers in different parts of the town. The shook-staves were shaved into shape, and set up with truss hoops in the shape of a hogshead, and heated until they were bent into proper shape; then knocked down, and each packed in a bundle, not unlike the clapboards. The barrels and shooks were carted by ox-teams to the cities, the barrels to be filled with rum, beef, pork, etc., and the shooks were exported to the West Indies and other parts, set up, headed, and filled with molasses. Large quantities of hard pine were cut and burned into charcoal for blacksmiths' use and other purposes. This brings us down to the second period of lumbering in this state. During these years was the flax-growing period among the farmers."

Masting was not uncommon in New Hampshire an hundred years ago. It was carried on under a "mast-master," who selected the trees to be cut, how they were to be felled, and how trimmed and loaded for removal from the forest. In some instances

some two and one third millions (2,375,680) of acres of forest area. Upon this the trees are irregularly distributed, just as neglect or a reckless management may have left them.

It is probable, almost to a certainty, that our wooded areas have increased rather than diminished during the last twenty-five years. But this increase, if such there is, comes rather from the abandonment to nature of worn-out fields and pastures, whose culture was no longer profitable, than from any particular desire to enlarge our forests. Our primeval woods and others of mature age have been diminished in this period, and, although our fuel supply may possibly have held its own, that of our timber has been very largely reduced. We have already reached a point where large quantities of the best timber we use are necessarily imported from the West, or from Canada. But for new and increasing facilities of transportation, we should now be suffering from a timber famine, of much inconvenience, to say the least.

Yet our forests are still of great value, and with proper care will maintain their productiveness, and yield reliable returns indefinitely. If we examine them, we shall find their woods of excellent quality and in large variety. It is easy to enumerate

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their conveyance to the river, down which they were floated to their destination, required not less than forty yoke of oxen, and a corresponding number of teamsters and "tailmen." The duty of the latter was to pull by their tails the rear oxen from under the forward end of the mast, when, upon crossing a sharp elevation, it pitched suddenly downwards, and would strike them unless pulled aside. During this part of the work the mast-master was on horseback, and gave it superintendence all along the line.

Tradition tells us of an immense mast, for which the mast-master was to receive one thousand dollars when delivered in good condition at Newburyport. It was safely drawn from the woods, and launched from the bank of the Contoocook. It passed safely over the Fisherville falls, as well as all below on the Merrimack as far as those of Amoskeag. Here it floated directly across the rapids, while its ends struck the rocks upon the opposite shores. Here it lay immovable, breasting the whole volume of the river. In these days it would be an easy matter to dislodge such a stick. The most feasible means to do this, then thought, was to shoot down the current against it another large log to strike against and dislodge it. The first sent down passed over it. The second passed underneath it. The third struck it, and broke it in two. When the mast-master saw what had been done, he simply remarked that he was a ruined man; rode into the woods, and disappeared forever after.

In his diary for the year 1764, the Rev. Timothy Walker, of Concord, remarks as follows, viz.,—

"Mon. Jan. 9. Ye mast team set out."
"Tues. Jan. 17. At night Prince with one yoke of oxen went into the mast camp."
"Wed. Jan. 18. Mr. Webster hauled his great mast at night."

from memory more than forty, and still leave the list incomplete.

We have not less than five species of oak, viz.,—

1. *White oak* (Quercus alba).
2. *Chestnut oak* (Q. castanea).
3. *Scarlet oak* (Q. coccinea).
4. *Black oak* (Q. tinctoria).
5. *Red oak* (Q. rubra).

Compared with the western oaks, ours are heavier and tougher. Where strength is required, they are of greater value. No oak, if we except the live oak of the South, is stronger, or of greater specific gravity, than our white oak. Where strength and stiffness are the qualities sought, I know of no varieties grown elsewhere which excel our red oak.

Our forests give us two species of ash of great excellence, viz.,—

6. *White ash* (Fraximus acuminata).
7. *Brown ash* (F. sambucifolia).

No timber combines the three qualities of lightness, strength, and stiffness in equal degree with our white ash. The supply of this has been of great importance in carriage manufacturing, long an important industry in some localities of our state.

They also give us four kinds of birch, viz.,—

8. *Black birch* (Betula lenta).
9. *Yellow birch* (B. excelsa).
10. *White birch* (B. populifolia).
11. *Canoe birch* (B. papyracea).

For some years past birch has been largely used in the manufacture of furniture, house finishings, and many smaller articles. The piles of it annually used in the manufacture of bedsteads at our state prison are immense.

We have two varieties of elm, viz.,—

12. *While elm* (Ulmus Americana).
13. *Slippery elm* (U. fulva).

The latter of these is not very common. The first is more so, and in open grounds makes the finest shade-tree we have, living to a great age and attaining to a great size. Five elms upon Main street in Concord, set out in 1764, by the Rev. Timothy

Walker, have the following circumferences at three feet from the ground, viz.,—

The 1st, sixteen feet and nine inches.

The 2d, fourteen feet and eight inches.

The 3d, nine feet and seven inches.

The 4th, thirteen feet and seven inches.

The 5th, fourteen feet and four inches.*

In carriage-building elm wood is important, as affording the best material for wheel-hubs of any in general use.

Four kinds of maple, all attaining to good size, may be found in our woods, viz.,—

14. *Rock maple* (Acer saccharinum).

15. *White maple* (A. criocarpum).

16. *Red maple* (A. rubrum), and

17. *Black sugar maple* (A. nigrum).

The first of these has a value universally appreciated, and its range of uses is both large and important. The richness of its sap in saccharine properties makes it valuable as a sugar-producing tree.

Our woods afford us but one variety of

18. *Chestnut* (Castanea vesca).

The wood of this tree, formerly but lightly esteemed, has grown in value as its fitness for specific uses has been discovered. It long resists decay when exposed to moisture, and is largely used for railroad ties, fence posts, furniture, and to some extent for house finishing.

Nor have we more than a single species of the following, viz,—

19. *Beech* (Fagus sylvatica).

20. *Tupelo* (Nyssa aquatica), a hard and heavy wood but little esteemed, particularly for fuel, the interlacing of its fibres rendering it very hard to split.

21. *Lever wood* (Ostrya Virginica).

22. *Horn-beam* (Carpinus Americana).

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* The sizes of these trees in 1853 were as follows, viz.,—The 1st, sixteen feet; the 2d, twelve feet and nine inches; the 3d, nine feet; the 4th, thirteen feet; the 5th, twelve feet and nine inches.

Comparing these dimensions with those given in the text above, it will be seen that the aggregate gain in circumference of these five elms during the last thirty years has been five feet and five inches. They are still, at one hundred and nineteen years from their planting, vigorous old Nestors, and promise a good record for the next thirty years. J. B. W.

23. *Black alder* (Alnus incana).

24. *Mountain ash* (Pyrus Americana).

25. *Butternut* (Juglans cinerea).

26. *Mulberry* (Morus alba).

27. *Buttonwood* (Platanus occidentalis).

28. *Poplar* (Populus tremuloides), which, but little esteemed formerly, has of late been much used in the manufacture of excelsior and paper stock. Its rapid growth and the immense consumption of paper, all the while increasing, has raised it to a rank of much importance.

29. *Basswood* (Tilia Americana). The wood of this tree, combining as it does the qualities of lightness, closeness of grain, and strength, is of great value in carriage-building, and to some extent in carpentry.

We have two species of walnut, viz.,—

30. *Shell-bark hickory* (Carya alba).

31. *Pig-nut hickory* (C. porcina).

The first of these stands at the head of all American woods as a fuel, and was made by Marcus Bull his standard of comparison in his experiments upon the relative heating values of different woods. Its solidity of texture and its strength render it a wood of great value in the arts.

We have also but one variety each of the

32. *Hackmatack* (Larix Americana).

33. *Hemlock* (Abies Canadensis).

34. *Balsam fir* (A. balsamea).

35. *Black spruce* (A. nigra).

36. *White spruce* (A. alba).

The four last of these are evergreens, and furnish a large portion of our building timber.

Our forests yield us two valuable species of cherry, viz.,—

37. *Wild red cherry* (Prunus Pennsylvanica), and

38. *Wild black cherry* (P. serotina); and three species of pine, viz.,—

39. *White pine* (Pinus strobus).

40. *Pitch pine* (P. rigida).

41. *Norway pine* (P. resinosa).

We also find in them the

42. *Arbor vitæ* (Thuja occidentalis).

The varieties of trees thus far enumerated amount to forty-two. I have purposely omitted many, as the *willow*, of which we have at least sixteen distinct species, the *Balm of Gilead*, the *Lombardy poplar*, the *striped maple*, the *scrub oak*, etc., being of less value on account of size or quality of wood. This list might easily be extended, but is amply sufficient to show clearly the great value of our forests.*

Some of these trees are pretty strictly confined to particular localities: some are scattered over all parts of the state. If we run a line from Hanover eastward to the north end of Winnipiseogee lake, and thence north-easterly so as to strike the upper edge of the sand plains about Madison and Conway, we shall divide the state into two tolerably equal parts, the northern having a little higher latitude and a considerably higher altitude than the southern. Each, upon examination, will be found to possess a flora differing considerably from that of the other.

In the northern half, we shall find predominating the spruces, the arbor vitæ, the rock maple, and the beech; in the southern, the oaks, the elms, the river maple, and the walnut are common, and give character to the forests. The chestnut very rarely, if ever, grows in the northern section, and is found only in localities of limited extent in the southern. The pitch pine is confined mostly to the sand plains. The white pine, however, grows at almost any moderate altitude, and in any latitude within our limits, generally following the river valleys and adjoining slopes all the way from the Massachusetts line to Canada.

But the timber trees of our forests are, unfortunately, unevenly distributed over the surface they occupy. Fires, reckless cuttings, and neglect have rendered many of the growths very uneven. While some acres would yield twenty-five thousand feet, or very much more, others adjoining will afford less than five. Artificial planting has never been practised in New Hampshire, and our woods consequently are composed of chance varieties of trees indiscriminately mingled by natural seedings. The advantages incident to a regular disposition of specific

* More or less confusion exists in the books as to the true scientific names of some of the trees of this list, but it is hoped that those given above may be correct, having been carefully examined and revised by Mr. Moses Woolson, of Concord, one of the best arboreal botanists in New England.

varieties of trees upon timbered acres have never yet been enjoyed, and but rarely even dreamed of, in New Hampshire.

OUR FOREST MANAGEMENT.

The management of our forests, or rather their treatment, for I cannot conscientiously use the word management in this connection, has been by no means uniform. It has been governed a good deal by the capricious notions of their owners, sometimes by the nature of their growths, and at other times by their location. Present profit has been the governing consideration in its determination.

In the older parts of the state, where wood and timber are most valuable, it is a common practice to remove from time to time old and decaying trees, and often with such care as to save from injury the surrounding growth. A forest thus treated for a long period improves but little, and yields but a meagre income.

Some owners have been induced at times, by offers of timber contractors, which they deemed tempting, to allow the removal of trees of specific kinds and dimensions scattered throughout their forests. The opening of roads for this purpose necessitates, of course, the destruction of many others, for which the owner receives insufficient compensation. Such a practice increases greatly the unevenness of growth common to natural forests, and is as injurious as it is stupid.

In the primeval forests of the northern part of the state, where stumpage is cheap and lumbering operations extensive, it is often the custom to remove those trees only which are above an established minimum size, reserving for future cuttings all below it. This is frequently fixed at eight or nine inches of diameter at the ground. Such a practice allows subsequent cuttings at intervals of twenty years or thereabouts. The considerations in support of it are the remoteness of forests, the high expense of transportation, and the slight value of small timber. Those against it are the destruction of much young growth by the opening of roads, the cumbering of the ground with large quantities of *débris* which become dangerous in case of fire, and the creation of vacant spots upon the lot.

A prominent lumberman in the northern part of the state remarked to me a short time since that he thought it wise to cut no trees of a butt diameter less than twelve inches, and that with

some addition to his present forests he could cut perpetually all the lumber he cared to market, as the new growth would keep pace with that removed. What kind of landed estate can be more desirable than this, where unaided nature supplies the crop, and only asks its removal that it may give place for a new one?

We occasionally find coppice woods in the lower part of the state, particularly in the vicinity of large towns where wood is in demand and brings good prices. Under this treatment the entire growth is removed by clean cuttings at intervals of from twenty to forty years. Such forests produce only small timber and wood. But the demand for the former, which has arisen in later years, renders its culture profitable. Indeed, it would be difficult to mention a better paying timber crop than one of white pine, which is of rapid growth, and always in active demand for the manufacture of pails, tubs, kits, casks, boxes, etc.

In very rare instances, if at all, do we find persons intelligently engaged in the systematic culture of large timber. The most valuable trees of our forests require for the attainment of full maturity a period of from sixty to a hundred years, according to the variety of tree, soil, and exposure.*

*Eighty-five logs, cut some years since in and about Concord, were found upon careful examination to have the following butt diameters, numbers of annual rings, and average increase of butt diameters per annum, viz.:

FORTY WHITE PINE LOGS.

Diameters.	No. rings.	Average annual increase.	Diameters.	No. rings.	Average annual increase.
			425	1,713	5.00
19 inches	75	.25 inch per annum.	35 inches	92	.38 inch per an'um
22 "	72	.30 "	27 "	91	.30 "
24 "	73	.33 "	30 "	95	.32 "
20 "	82	.24 "	23 "	92	.25 "
21 "	83	.27 "	16 "	96	.17 "
19 "	89	.21 "	23 "	50	.46 "
20 "	90	.22 "	31 "	91	.34 "
19 "	80	.24 "	21 "	54	.40 "
14 "	87	.17 "	30 "	93	.32 "
25 "	90	.28 "	16 "	68	.24 "
12 "	80	.15 "	26 "	80	.30 "
22 "	93	.24 "	25 "	80	.30 "
23 "	92	.25 "	30 "	90	.33 "
22 "	91	.24 "	20 "	91	.22 "
23 "	86	.27 "	20 "	89	.23 "
27 "	90	.30 "	12 "	60	.20 "
23 "	94	.24 "	20 "	86	.21 "
30 "	86	.35 "	18 "	99	.18 "
17 "	89	.20 "	38 "	164	.23 "
23 "	91	.25 "	22 "	107	.22 "
425 inches	1,713	5.00	908 inches	3,471	10.60
			Av. di'rs, 22.70 in.	Av. No. r's, 86.77	Av. annual incr'se, .265 inches.

The genius of our law, and the entire absence of established families, have thus far discouraged enterprises requiring so much time. Such, probably, will continue to be the case, until eventually, in the not very distant future, the scarcity and increased price of lumber, and greatly augmented wealth seeking investment, shall warrant artificial planting. When a knowledge

TWENTY CHESTNUT LOGS.

18 inches	49	.37 inch per annum.	225	762	2.93
16 "	81	.20 "	19 inches	65	.29 inch per an'um
20 "	78	.26 "	16 "	70	.23 "
22 "	87	.25 "	20 "	75	.36 "
24 "	91	.26 "	23 "	98	.25 "
29 "	70	.33 "	21 "	77	.27 "
30 "	80	.38 "	17 "	64	.27 "
27 "	70	.38 "	25 "	72	.35 "
20 "	82	.24 "	25 "	71	.36 "
19 "	74	.26 "	14 "	61	.21 "
			23 "	70	.30 "
225 inches	762	2.93	428 inches	1,480	5.72
			Av. di'rs, 21.40 in.	Av. No. r's, 74	Av. annual incr'se, .286 inches.

TWENTY RED OAK LOGS.

Diameters.	No. rings.	Average annual increase.	Diameters.	No. rings.	Average annual increase.
			176	753	2.52
36 inches	64	.56 inch per annum.	13 inches	58	.19 inch per an'um
25 "	69	.36 "	26 "	62	.42 "
11 "	35	.31 "	15 "	60	.25 "
18 "	115	.16 "	15 "	79	.19 "
16 "	110	.15 "	18 "	59	.30 "
13 "	100	.13 "	14 "	55	.25 "
19 "	65	.29 "	15 "	80	.19 "
11 "	61	.16 "	36 "	78	.48 "
12 "	70	.17 "	21 "	63	.33 "
15 "	64	.23 "	15 "	60	.25 "
176 inches	753	2.52	364 inches	1,402	5.37
			Av. di'rs, 18 inches.	Av. No. r's, 70	Av. annual incr'se, .27 inch.

FIVE HEMLOCK LOGS.

24 inches	68	.36 inch per annum.	55	195	.85
17 "	74	.23 "	13 inches	53	.24 inch per an'um
14 "	53	.26 "	18 "	140	.13 "
			.....	.....	.....
55 inches	195	.85	86 inches	388	1.22
			Av. di'rs, 17.20 in.	Av. No. r's, 77.60	Av. annual incr'se, .24 inch.

of the important fact becomes general, that forests thus produced are profitable, they will as surely appear in the United States as they have in England and upon the Continent. Indeed, they are already here, and thousands upon thousands of acres of plantations may be seen in our newer prairie states.

In short, thus far we have had but little intelligent forest management in New Hampshire. The certain spontaneity with which new woods naturally succeed to old ones when removed, together with the moderate prices of lumber which until lately have prevailed, has kept us satisfied with the growth which undirected and unassisted nature has given us. But the rapid lessening of our timber supply must soon bring us to a consideration of settled systems of forest culture similar to those adopted by other peoples whose spontaneous forests had disappeared.

The superiority of systematic planting over the indiscriminate seedings of nature has been demonstrated over and over again by such experiments as those made by successive dukes of Athol during the last hundred years in Scotland. The returns of wood and timber, to say nothing of the improvement of the lands from such plantations, have far exceeded the interest upon the investments. Twenty-five thousand feet of timber per acre is above the average yield of most of our native forests; and that of indiscriminate varieties. Well conducted plantations would easily yield twice that amount in the same time, and that too of the varieties desired. Regular cuttings of mature timber would supplant the indiscriminate slashings at chance times of both ripe and unripe trees.

WASTE OF OUR FORESTS.

The rapid destruction of our forests now in progress is attracting general attention, and exciting well founded apprehensions

It will be seen by the foregoing that the rate of annual growth varies greatly in different trees,—among the pines, from .15 inch to .46 inch; among the chestnuts, from .20 inch to .38 inch; among the red oaks, from .13 inch to .56 inch; among the hemlocks, from .13 inch to .36 inch. My note-book also shows that the rate of growth varies greatly at different periods in the same tree. Two inches in diameter of a tree gave 43 rings at one period of its growth, and 18 rings at another. Eight several inches in diameter of a hemlock gave respectively 10, 11, 13, 12, 16, 15, 16, 26 rings. The observations above recorded show that the chestnuts and the red oaks have grown the most rapidly, while the slowest growing of the four varieties was the hemlock.

of a timber famine at no distant day. Although our wooded area may not be lessening, but rather increasing, the supply of mature timber is diminishing rapidly. This fact is patent in all parts of the state.

Within the recollection of most of us, a common phraseology of the advertisements of farms for sale represented them as "suitably divided into tillage, pasture, and wood land." Every farm had its wood and timber lot. In exceptional cases only was this wanting. Not unfrequently it was of more value than all the rest of the farm, buildings included. But such is no longer the case. Hundreds of farms consist now of their fields and pastures only, having growing wood barely sufficient for the farmer's fire. If, therefore, upon examination of the census returns we find a decline in the value of farm property, we must attribute it in no small degree to the removal of its wood and timber.

The causes of this rapid disappearance of our older and heavier forests are various. Among them we may note,—

1. Their exposure to high taxation. As the lumber supply diminishes and its value increases, a forest which formerly attracted little attention now commands general notice, and is quite sure to receive commendation from the town assessor by an increased valuation. The owner, after remonstrating for a while to no purpose, rights his grievance by the only means in his power,—by the sale to some lumber contractor of nearly or quite all the merchantable timber upon his farm. We cannot say what becomes of the purchase-money, but we all very well know that the impelling motive of the sale was the avoidance of high taxation.

2. The enhanced value of lumber as transportation and manufacturing interests have been developed has induced many owning this kind of property to realize upon their investments. They have argued, and argued truly, that the interest of the money to be realized from the sale of a mature forest, added to the new growth sure to follow its removal, will exceed the value of the growth of the old forest. In such cases it would generally be unwise not to sell.

3. Another cause is the needless destruction every year of considerable areas of wood and timber by fires carelessly and

maliciously kindled, and against which the owner has no sufficient protection. In the sparsely settled parts of the state, particularly upon the mountains, fires thus kindled often burn for weeks, their extinguishment being impracticable.

Woods near our large towns are particularly exposed. Report was made at an agricultural meeting held in this city last January, that a man had been compelled to sell a wood and timber lot, valued at $13,000, lying within a few miles of the city hall, for the simple reason that he could not protect it from the fires started by tramps and other worthless human vermin which infested its neighborhood, particularly on Sundays. The liability encountered in the vicinity of Manchester, exists to a greater or less degree in the neighborhoods of all our large towns. Unless the same protection be secured to forests as other property in such localities enjoys, they must inevitably soon disappear.

4. The stupid and reckless treatment of forests by their owners, by no means uncommon, has much to do in rendering them less productive than they might and otherwise would be.* The cuttings are very often without system, and wasteful. Vacant spots are made, and the new trees springing up thereon are obliged to struggle as best they can in the shade of the overhanging tops of the surrounding growth. Cattle and sheep are frequently allowed to browse in young woods, notwithstanding the injury done to the young trees exceeds ten times the good accruing to the herds and flocks. Indeed, the practice has been well-nigh universal, of taking from our forests all they have to yield, and of returning to them neither gratitude, culture, nor protection. The greatest kindness accorded them has been that of neglect. The prevailing idea has been that nature made the forests, and that nature should also take care of them.

5. And the state itself, I regret to say, has done her full share in the sad destruction which we all lament, by selling to lumber operators in 1867 the whole body of her very valuable timber lands lying in the three counties of Carroll, Grafton, and

* A circular of one of the leading leather firms in Boston says, in reference to the procuring of hemlock bark partly in Maine and partly over the line in the British Provinces,—"Every tree has to be cut down to get the bark, and hemlock forests can never be replaced. We cut down in 1861 at least fifty thousand hemlock trees that must rot upon the ground."—*Boston Daily Advertiser*, February 5, 1868, page 8.

Coös, amounting, according to the deeds of conveyance, to one hundred and seventy-two thousand acres, more or less. For how much, do you ask? For the stupendous sum of twenty-five thousand dollars, or fourteen cents and a half an acre, as appears by copies of three deeds of conveyance preserved in the office of the secretary of state.* The only consolation to be derived from this extraordinary transaction is, that the state thereby secured itself against further folly in this direction by the sale of its last forest acre.

It may be interesting to note, in passing, some of the particular agencies now active in the destruction of our forests. The railroads and manufactories of various kinds have for many years been calling for large quantities of wood and lumber. Most of the forests formerly found in their vicinity exist now only in the representative sapling growths which have succeeded them. Already these great consumers find that their supplies

* By the first deed, dated October 17, 1867, for the sum of five hundred dollars the state conveyed "all and singular, the lands belonging to the state of New Hampshire, lying and being within a circular area six miles in diameter, of which the centre is the centre of the Tip-Top House on the summit of Mount Washington, in the county of Coös in said state, and extending three miles in any direction from the centre of said Tip-Top House, all situate in the county of Coös aforesaid, and estimated to be two thousand acres in the whole, more or less, meaning and intending hereby to transfer and assign to said Aurin M. Chase, his heirs and assigns forever, all the right, title, and interest of the state of New Hampshire in and unto any and all lands within the limits of the aforesaid circle, however the same may be located and bounded and whatever the number of acres."

By the second, dated October 27, 1867, for the sum of twenty thousand five hundred dollars it conveyed "all and singular, the lands belonging to said state of New Hampshire, situate and lying within the limits of the town of Pittsburg, in the county of Coös in said state of New Hampshire, however located and bounded, estimated at seventy thousand acres, more or less, excepting and reserving therefrom to each of two actual *bona fide* settlers now supposed to be resident upon said lands, if they or either of them shall prove to be so actually resident thereon, so much of said land as each of said settlers or either of them may have actually improved or inclosed, not exceeding one hundred acres in all to each or either of said actual settlers."

By the third, dated November 5, 1867, for the sum of four thousand dollars it conveyed "all and singular, the lands belonging to the state of New Hampshire, or in which the said state of New Hampshire has or might have any right, title, interest, or claim in any way whatever, situate and lying within the limits of the counties of Grafton, Carroll, and Coös in said state of New Hampshire, however located and bounded, estimated at one hundred thousand acres, more or less, meaning and intending hereby to assign and convey to said Woods and Smith, their heirs and assigns forever, all and singular, the lands in said counties of Grafton, Carroll, and Coös, to which the said state of New Hampshire has or might have any claim or title in any way whatever, excepting and reserving from said grants the arsenal lot in Lancaster in the county of Coös, and any gun-house lot owned by the state in said counties of Grafton, Carroll, and Coös aforesaid."

have receded, and that they are becoming more and more dependent upon the wood lands of other states. The wood annually consumed by the railroads centring at Concord is not less than about seventy thousand cords, to say nothing of the thousands of ties, and the vast amounts of other lumber used in their shops and upon their various buildings and fences. The contractor of the state prison labor is annually converting into bedsteads nearly four millions (3,756,000) of feet. What an entire city like Manchester consumes I have not the means to state, but enough surely to denude thousands of forest acres.

And the foreign demand upon our wood lands is as great, probably, as the domestic—a fact to be greatly deplored, inasmuch as New Hampshire receives for its exported lumber little more than the stumpage, to which is to be sometimes added the saw bill. The millions of logs which float down the Merrimack every spring yield to persons within the state less than one tenth of their ultimate value, the balance of which goes to parties in Maine, Massachusetts, or Connecticut, as the case may be.

I learned at Milan, a few years since, from one of the prominent lumber operators of northern New Hampshire, that Coös county had then standing in its woods about twelve hundred millions of feet of merchantable lumber. This has been since drawn upon at the rate of from seventy-five to one hundred millions per annum. How long at this rate of cutting will the forests of Coös hold out? And how much, when it is gone, will Coös have received for it?

But these large operations, common to our northern forests, are not so entirely destructive as the portable saw-mills now moving all over the state, particularly the lower half of it. The former may be compared to the hail plague in Egypt, as they usually destroy but partially a forest growth, leaving the smaller trees unmolested. But the latter represent most faithfully the succeeding plague of locusts, "very grievous; before which were none such locusts as they, neither after them shall be such."

When a portable saw-mill locates in a forest, it is liable to consume all the trees around it for a mile or more, every one of them, from

"The mighty oak,
By whose immovable stem one stands and seems
Almost annihilated,"

to the young sapling just rising into vigorous life.

Our Saxon ancestors upon the east coast of England used to put up prayers in their churches for deliverance from the visitations of the Danes. As wisely does it become us to seek deliverance from the very frequent visitations of these portable mills. No less than five of them have been actively at work in Canterbury this very winter, upon the remaining timber lots of that old town. A few years ago one was set up in Concord, within a mile of the state-house, and before its removal to another section it had swept off the entire growth of three hundred and fifty acres, amounting to some seven millions of feet, and left standing hardly a tree of sufficient size for an ordinary goad-stick.

That the valuation of our farm property must diminish under a continuance of such reckless destruction of the forests is as sure as destiny. That our lumber supplies will grow dearer as they grow less, is just as sure. That a timber famine impends in the near future, to be averted only by supplies from abroad at extravagant prices, who can doubt?

USES OF FORESTS.

It may be well that we consider for a few minutes, just here, some of the uses or offices of forests. These are more numerous and more important than is generally supposed.

1. The first sure to occur to us is that of producing the wood and lumber, without which modern civilization would be an impossibility. The ways in which wood is employed in the occupations of daily life are simply innumerable. From the time when, as an infant, he is placed in his willow carriage, all the way on through life until he is lain to his long rest in his wooden casket, the man of our day is in the constant use of this material.

Nor can there be found for it any general substitute. Metals and clay and stone can take its place in but very few instances.

We cannot finish or furnish a house without it. We cannot build a mill without it. Without it we cannot carry on a farm. Without it we can hardly journey upon the highway, and we are surrounded by it whenever we enter a railway car. It makes a part of our daily newspaper, and a part of the pen which records our daily correspondence. Extensive and minute, restricted and infinite, are its uses. To the forests only can we look for a supply of it.

2. In a country like ours, where cold prevails for half the year, and is rendered more severe at times by winds, forest shelter is of great importance. The rays of the sun are but gay deceivers, if their warmth is to be swept away by a strong north-west wind. You have noticed that vegetation languishes upon grounds exposed to it. Farmers object to the fall plowing of such, from a wise fear that more or less of the soil will take to itself wings and fly away.*

The shelter furnished by forests to cleared land is little less important to the latter than is the protection of their stables to our herds and flocks. Where the sides of our valleys are covered with trees, the colder air of the surrounding elevations is partially arrested in its downward flow, to the very welcome mitigation of their temperature. The blizzards, of which we hear much in late years, are of rare occurrence in a wooded country.

3. The presence of woods increases much the rain-fall of a country, particularly in summer, when droughts are apprehended.† When, at this season, rain-bearing clouds float over us from the ocean, the low temperature of the forests and the coolness exhaling therefrom help greatly to condense these into

* A spectator, placed on the famous bell-tower of the cathedral at Antwerp, saw not long since, on the opposite side of the Schelde, only a vast desert plain: now he sees a forest, the limits of which are confounded with the horizon. Let him enter within its shade;—the supposed forest is but a system of regular rows of trees, the oldest of which is not forty years of age. These plantations have ameliorated the climate which had doomed to sterility the soil where they are planted. While the tempest is violently agitating their tops, the air a little below is still, and sands far more barren than the plateau of La Hague have been transformed under their protection to fertile fields."—*Revue des Deux Mondes*, January, 1859.

† A writer in the American Cyclopedia, speaking of the island of St. Thomas, W. I., says, "The surface is elevated and rough, highest in the centre. It was formerly well wooded, but the cutting off of the wood has subjected it to frequent and severe droughts."

grateful showers. Were the same territory denuded, the ground, heated by the sun, would rarefy these masses of vapor, and the blessings with which they came freighted would be lavished elsewhere and beyond.

Nor is this cooling influence restricted to the clouds alone. It tempers the heat in the open grounds adjacent by the exhalation of moisture. To what extent this may be true we need experimentation to determine; but it is confidently asserted that a ton of hay exhales in growing no less than two and a half tons of water. Our idea of what a forest one square mile in extent would do may be vague, but it is also forcible.

4. But the influence of a forest is not confined to an increase of the rain-fall. It retains it for gradual use as needed. Its trees cover the ground with decaying leaves and other *débris*. They fill the soil with their countless roots, thereby opening through all parts of it minute channels for the passage of moisture. It is just here that the rills are born, which develop into brooks, which subsequently uniting make the rivers of a country. In short, the forests of the state are the great reservoirs in which it stores the water supplies upon which its animal and vegetable life depends for refreshment and support. As well might New York part with its Croton river as New Hampshire give up its forests.*

5. Under the forest's protecting tree-tops evaporation is slow, and much of the loss of moisture to which open grounds are subject is saved. Most of the winter's snow which falls upon these disappears by evaporation. The sun and the March winds carry its moisture we know not where. But little of it penetrates the ground hardened into rock by frost, which lasts as long generally as the snow.

In the woods the reverse is the case. The winds and the sun's rays are but little felt. The ground, frozen but slightly

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* In his "The Earth as Modified by Human Action," Hon. George P. Marsh says,— "It is an almost universal, and, I believe, well founded opinion, that the protection afforded by the forest against the escape of moisture from its soil by superficial flow and evaporation insures the permanence and regularity of natural springs, not only within the limits of the wood, but at some distance beyond its borders, and thus contributes to the supply of an element essential to both vegetable and animal life. As forests are destroyed, the springs which flowed from the woods, and, consequently, the greater water-courses fed by them, diminish both in number and volume."

if at all, thaws early, and the snow melting largely at the bottom descends into the open soil beneath. The bareness of our old pastures upon the hillsides is doubtless less due to soil exhaustion than to the want of moisture. The snows which fall upon them are largely lost by evaporation. The rains which they receive for the most part run down their indurated surfaces, penetrating the soil but slightly. As reservoirs for the storage and for the gradual supply of water, the forests of a country are of incalculable value, and indispensable.

When, two thousand years ago, it was a wooded country, Palestine bore sub-tropical fruits. Its present barrenness and desolation are largely due to its want of forests. Restore these, and its former productiveness will return, and it will become again "a land flowing with milk and honey."

EFFECTS OF DENUDATION.

To one who has observed the several influences of forests upon climate, the consequences of general denudation are as plain as the corollary of a demonstrated proposition.

1. Cut off the forests of New Hampshire, and our winters will become more severe, our springs and autumns more liable to unseasonable frosts, and the heat of mid-summer more intense. From November to May our climate will be arctic. From July to September it will be torrid.*

2. Summer droughts will become chronic. Agriculture will languish for the want of water. In some sections sterility, cheerless and hopeless, will prevail, accompanied often by its twin brother, desolation.† If some more favored portions

*The following well attested instance of a local change of climate is probably to be referred to the influence of the forest as a shelter against cold winds. To supply the extraordinary demand for Italian iron, occasioned by the exclusion of English iron, in the time of Napoleon I, the furnaces of the valley of Bergamo were stimulated to great activity. The ordinary production of charcoal not sufficing to feed the furnaces and the forges, the woods were felled, the copses cut before their time, and the whole economy of the forest was deranged. At Piazzatorre there was such a devastation of the woods, and consequently such an increased severity of climate, that maize no longer ripened. An association, formed for the purpose, effected the restoration of the forest, and maize flourishes again in the fields of Piazzatorre."—*The Earth as Modified by Human Action*, page 164.

†"FORESTS AND MOISTURE. The Manchester *Union* has an interesting article discussing the causes of the present low state of water in our lakes and rivers, and hinting at the results which may be expected to follow. Certainly the present condition

escape this fate, they will owe their good fortune to the presence of mountain elevations, or their nearness to the sea.

3. Cut off our forests, and instead of even flowing streams, we shall have mountain torrents in spring and dry channels in mid-summer. The water-power of New Hampshire will be fearfully reduced, and our great manufacturing establishments will be compelled to look to steam or electricity for motive power. To what extent the water-power of the state has already been diminished from this cause, you, Mr. President, and other gentlemen who are residents of this great industrial metropolis of our state, can best estimate. Many of the smaller streams, more or less of which we all knew in our youth, and which were then of respectable volume the year round, have either dwindled to insignificance, or are absent altogether for nine months out of every twelve.

4. Cut off our forests, and the forty-five thousand farmers of New Hampshire will lose much of the winter occupation they may now enjoy. One prominent reason why farming is less remunerative than it might be must be attributed to the fact that while in most avocations work is constant the year round, in this it is largely confined to the period when the land is free from frost. Secure to each farm a suitable portion of wood

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of things is unusual. The present drought is not confined alone to our state, but prevails elsewhere. It is everywhere regarded as temporary and extraordinary, and people expect soon to see it followed by a heavy rain-fall which shall fill the springs and swell the streams to their former size. But while this lack of water is looked upon as something exceptional and out of the ordinary course, it cannot escape our notice that our streams are not as large as formerly. Few men in middle life, who were reared on farms, and went hunting and fishing as farmers' boys are wont to do, can have failed to notice that a marked change has come over the brooks which they knew in their boyhood. They have been surprised when visiting their old playing grounds to find some brooks entirely dry, and others so much smaller than they once knew them. There is a general agreement of opinion in charging this change to the rapid cutting off of our forest growth. When the railroads were first opened into our state, our hills were covered with a heavy growth on which the yearly attacks of the woodman's axe made no perceptible impression. The new growth would fully make amends for that carried away by lumbermen. But this condition of things no longer exists, and immense forests are slaughtered with a rapidity which the natural growth is far from making good. The sources of many mountain springs are uncovered, and dried up by the scorching sun of summer. The moisture is no longer retained as it used to be in thick forests, tempering with its delicious coolness the heat of summer, and inviting showers from clouds which now pass by without one drop of welcome rain. And when the rain does come, it runs away into the brooks instead of being held in the shade of our woods as formerly. This is the theory for the disappearance of brooks and the diminishing volume of water in our rivers."—*Laconia Democrat.*

and timber land, and the exercise of a fair knowledge of forestry, and its owner may have as remunerative occupation in winter as at other seasons of the year, being thereby relieved of the necessity of consuming in four months of idleness the surplus acquired in the remaining eight of activity.

5. Owing in part to its accessibility and in part to its pure air and fine scenery, New Hampshire is becoming more and more a summer resort to the five or six millions of people who can comfortably transfer themselves from their homes to our hillsides and mountains in some twenty-four hours or less. The number of our summer visitors has been steadily increasing for the last forty years, and during the last ten with great rapidity. The proprietor of a mountain hotel remarked in my hearing, a few years since, that he well remembered when the total receipts of all the White Mountain houses were but about twelve thousand dollars a year, but that such had been the increase that they amounted then to about twelve hundred thousand. What our whole state received last year from its summer visitors is, in the absence of reliable statistics, conjectural only; but the number of them coming to us for longer or shorter periods is estimated by the millions, and placed far above the trebled or sextupled population of our state.

Whatever the actual number may have been, these came here for rest, for recreation, for the invigoration of both body and mind. Some sought the seashore, but more the mountains and the quiet nooks of the hill-country. Cool and invigorating air attracted some. Green fields and country roads, clear skies and fine scenery, afforded enjoyment to thousands of them. Many a one, a serene and faithful follower of dear old Izaak Walton of saintly memory, has annually said to his companions, in the language of the apostle Peter, "I go a fishing:" and they, in reply, have said, "We also will go with thee." Many akin to Nimrod have penetrated the woods, and the pursuit of game has been their pastime.

Sweep the forests from our mountains and hills and lakesides and river banks, and the summer sun will blaze upon their parched surfaces with a fervor like that with which it heats unendurably the city pavements from which many of these have fled. Our small streams will disappear; the volumes of our

rivers and the surfaces of our lakes will shrink wofully; the millions which now visit us will stay away; our population will dwindle; and this goodly heritage will become in its most busy season as desolate as the campagna of old Rome, and as unattractive as the Sahara.

One half, doubtless, of our state may be profitably kept in forest. The specific areas should vary, of course, somewhat at different periods, but that much of its surface should be kept continually covered. A cursory survey of the state's topography will show the truth of this remark. We have five great river basins, separated from each other by extensive hill and mountain ranges. Very generally these latter are incapable of profitable cultivation, but will produce trees perpetually. Within these basins are also many rough and barren lands, fit only for wood. Others still there are, which, owing to their situation, it is important to keep covered, as shelter barriers to break the force of high winds and protect the lands in culture or in pasture. If looked at from such a stand-point, one half at least, and probably considerably more, of the surface of New Hampshire will be clearly seen to require a constant forest covering.

PRESERVATION OF OUR FORESTS.

The alarm so generally manifest at the rapid destruction of our forests is not a groundless one. If denudation continues at its present rate for the next twenty years, we shall have no woodlands left worthy the name of forests. This alarm has come none too soon, nor, indeed, too late, if there can be wise and resolute action for their protection and improvement. The important inquiry everywhere heard just now is, What can be done?*

*"PROGRESS ON THE FORESTRY QUESTION. The increasing interest attending the consideration of the question of the best methods of preserving and extending the forests of New England, is indicated by the course of the Vermont legislature in appointing a Forestry Commission, and by the first meeting of the New Hampshire Forestry Commission at Concord on Wednesday. The Vermont commission is instructed to investigate the whole subject of the condition of the forests, and the measures needed for their protection; and the New Hampshire commission has already instituted measures for collecting information relative to the clearing of New Hampshire forests, and the injury caused thereby to the water supply. The inquiries set on foot by these commissions will serve a double purpose, in arousing the public attention to the importance of the interests affected, and in supplying the accurate information

1. The first thing to be done evidently is to obtain accurate information relative to the present extent, condition, and management of our forests. We need to know

Their total area in acres or square miles;

Their locations;

The character of the grounds they occupy, as to soils, elevations, exposures, drainage, etc.;

Of what trees they are composed;

The relative amounts of young, mature, and primeval growths;

The quantity of mature wood and timber now standing in the different counties of the state;

Its annual diminution by cutting, its annual increase by growth, and, as at present drawn upon, how long it will last.

When these inquiries, together with some others of a kindred nature, have been accurately answered, a solid basis of reliable facts will have been established, from which it will be safe to argue towards a solution of the great problem as to what can be done. If any of my remarks hitherto may have appeared to you vague, the fault is due to the want of the more definite information which I have sought for in vain in the authoritative returns to which I have had access.

But these requisite facts can be gathered only by persons qualified for the work, and particularly engaged to do it. They will not be collected and furnished as a labor of love, and those selected to procure them must be fairly compensated. The commission appointed under a joint resolution of the last legislature will doubtless give us much important information; but it was restricted simply to inquiries as to the extent of the destruction of our forests, the effects of recent denudation upon the rainfall, and the policy of enacting a code of forest laws. Wider inquiries than these are requisite, and must necessarily be made, if made at all, at the expense of the state.* And this the state

which is necessary to effective legislation. The rapid vanishing of New England forests before the axe, or by means of fire, is something the direct consequences of which, as connected with the timber supply, are serious enough. But the indirect consequences upon the soil and the climate and the water supply, although more recondite, are also more disastrous; and it is time that a persistent and well directed effort should be made to retrieve past errors before it is too late."—*Anon.*

* The immense variety, the many and important uses, and the great beauty of our forests, must naturally attract the attention of an observer; and, as the preservation

should assume, not only as a proper one, but as a penance for its sin in getting so humiliatingly cheated in the sales, before mentioned, of its forest lands. Without the main facts pertaining to this great subject, no one can satisfactorily answer the question, What can be done for the preservation and proper management of our forests? or, better, What should be done?

2. One other thing the state can easily and properly do. It can prescribe by law such penalties for the criminal or careless firing of forest lands as will hereafter secure their protection, and make it the special duty of officers therefor appointed to cause prosecution of all offenders under such a statute. Our present laws are entirely inadequate for the protection of our woods in this direction.*

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and improvement of the forests in their highest degree are above private effort, require joint action, and must be effected on a large scale,—on a system wisely begun and long continued by the men of one generation for those of the next,—and by the application of science, taste, and skill, not by one but by many men, not in one village or town but in a county and state, it is wise in a government not acting merely for the present, but extending its forethought generously onwards, making its knowledge and wisdom an invested capital for future use, and desiring to do for coming generations what they, when looking back, shall wish it had done,—it is wise, prudent, and patriotic for such a government to order a survey of the forests among its other domains, that the people may know the sources of their wealth and its extent, and learn how to value, enlarge, and enjoy it.—*Emerson's Trees and Shrubs of Massachusetts, page 1.*

* Our forefathers, as early certainly as 1680, and perhaps earlier, took measures to protect forest property, of which the following statutes of 1680, 1708, and 1718, may be cited as proof, viz.,—

"FIREING WOODS.

23. Whereas many have sustained great damage by indiscreet and untimely firing of the woods, It is ordered that none shall fire ye woods at any time between ye 1st of March and ye latter end of April; and if any shall unnecessarily fire the woods, or not observe this order, damnifie any, he shall make good the damage or be fined 10s. or sett in the stocks."—*Provincial Papers, Vol. I, page 392.*

"An Act passed by the General Court or Assembly of Her Majesty's Province of New Hampshire in New England. Begun and held at Portsmouth by adjournment, the Tenth day of May, 1708.

"An Act for the better preservation of all Mast Trees, or White Pine Trees, within Her Majesty's Province of New Hampshire.

"Whereas this Her Majesty's Province of New Hampshire, doth and may produce good quantities of White Pine trees, fit and serviceable for the masting of Her Majesty's Royal Navy; being desirous and with design to render the said Province as useful as may be to Her Most Sacred Majesty. And whereas Her Majesty, by her commission to John Bridges, Esq., Her Majesty's Surveyor General, for the time being, by themselves, or his or their Deputies, shall mark such of the said trees that now are or hereafter may be fit and proper to be taken for Her Majesty's Navy, and to keep a register of the same, thereby to prevent the destruction of such trees.

3. The improvement of our forests is of as vital interest as the encouragement of our manufactures. These have, in some instances, been exempted from taxation for limited periods, and the establishment of new enterprises has been encouraged thereby. A similar exemption of certain kinds of forests,—of those, for instance, from twenty to forty years of age, just passing from the state of unripe wood to mature timber,—might, upon a full examination of the subject, be found practicable and wise.

"Be it therefore enacted by the Governor, Council, and representatives convened in General Assembly, and by the authority of the same, That no person or persons within Her Majesty's Province of New Hampshire, shall presume to cut, fell, or destroy any white pine trees, or mast trees, not being the particular property of any private person, above the growth of twenty-four inches diameter at twelve inches from the earth, being fit to make masts for Her Majesty's Royal Navy, on the penalty or forfeiture of One Hundred Pounds sterling to Her Majesty, her heirs and successors, for every tree so cut, felled, or destroyed, without Her Majesty's Royal License, or her successors, first had and obtained for the same; which said sum of One Hundred Pounds shall be received by Bill or Plaint by Her Majesty's Surveyor General, for the time being, or his Deputy or Deputies in any Court of Record within this Her Majesty's Province, where there shall be no Effoiger, Protection or Wager in Law: Any Law custom or usage to the contrary notwithstanding: one Moiety of the said penalty to be for the support of this Her Majesty's Government, and the other Moiety to the informer that shall sue for the same.

"And be it further enacted, That no person whatsoever, excepting the Surveyor General, for the time being, his Deputy or other person authorized thereto by warrant under the Surveyor General's hand, presume to mark any Mast Trees with the broad arrow which is the mark hereby appointed, thereby to deter Her Majesty's good subjects from getting logs for lumber, or other uses, and to make a property of such trees to themselves, where the lands are common upon the same penalty, as above, to be recovered and divided as is before in this act expressed."—*Acts and Laws of New Hampshire, 1716, page 30.*

"An Act to prevent trespasses in Cutting down trees upon Land without Fence. (Passed May, 1718.)

"Be it enacted by His Excellency the Governour, Council, and Representatives, convened in General Assembly, and it is hereby enacted by the authority of the same, That whoever shall cut down any tree or trees, without leave from the owner or owners, shall pay to the party damnified twenty shillings, for each tree or more, according to the value of the trees. And the owner shall be accounted those, or such as derive a right from those to whom the land upon which said trees grow, is laid out, and bounded by the layers out of land, chosen in each town, or others legally appointed thereto; unless in such case where the right of timber belongs to one, and the right of land whereon said timber grows belongs to another, and then the damage accruing by such trespasses, shall be paid to him to whom the right of timber belongs.

"And whosoever shall cut down any bound-mark trees, shall pay a fine of forty shillings to His Majesty, his Heirs and successors towards the support of His Majesty's Government.

"And every Justice of the Peace within this Province shall have power to hear and determine the causes aforesaid. Always provided, that this act, or any thing therein contained shall not be understood to intermeddle with such trees as His Majesty hath been pleased to reserve for Masts, Bowsprits, and Yards, for supply of his Royal Navy."—*Acts and Laws of New Hampshire, page 65.*

As before remarked, high taxation has made our most valuable forests luxuries in which their owners are feeling more and more that they cannot afford to indulge.

4. There is another thing possible, but attended in its execution with so many practical difficulties that I only suggest without recommending it. It is the purchase, at low and established prices, by the state, of some of the denuded areas recently cut over, to be held and managed hereafter as public forests. Several of the countries of Europe hold and control large forests in the interest of the common weal. In some sections of the Alpine regions, but for this control the farms would be destroyed by spring torrents, and the lives of the inhabitants endangered by avalanches.

5. But inasmuch as the forests of New Hampshire are, without exception, private property, the state can do little comparatively to govern their management. Its power to legislate in their behalf is limited to the general authority accorded to it in its constitution, and their control rests almost entirely with their owners, upon whose pleasure their welfare is mainly dependent. Any scheme for their amelioration, very much beyond such as I have just indicated, must commend itself to their acceptance, or fail. And, governed almost entirely by imagined pecuniary interests, these will give it no support unless satisfied that it may benefit them in some degree.

If our forests are to be preserved, improved, and made permanently remunerative as investments of money, their owners are the persons to do it. This they may be led to do by a wider knowledge of the influence of forests upon climate, rain-fall, streams, and all adjoining property, as well as of systematic sylvaculture, and of the profits resulting therefrom through skilful removals and renewals of growths at stated periods, by which forest property may be made the safest and most profitable of all country real estate.*

* William Howitt, in his Rural Life of England, thus speaks of some of the Scotch plantations:

"The late Duke of Athol, John the Second, planted in the last year of his life 6,500 acres of mountain ground solely with the larch, which in the course of seventy-two years from the time of planting will be a forest of timber fit for the building of the largest class of ships in her majesty's navy. It will have been thinned out to about 400 trees per acre. Each tree will contain at least fifty cubic feet, or one load of tim-

In the spread of this information, an able commissioner of forests, supported by the state, should lead the way. His efforts may be very ably supplemented by lectures and discussions at the meetings of the board of agriculture and of the granges. The agricultural college, already doing what it can in this direction, and the public press, to which we are more indebted than to any other agency for awakening public interest upon the subject of our forests, should both be urged to continue their efficient services.* In a word, the future welfare of our forests depends in a measure upon the kind offices of the state, but mainly upon the maintenance of correct views of their value, and proper management by their owners and by an enlightened public.

If their highest welfare can be made permanently secure, all dangers of a timber famine will be averted, the attractions of our scenery will be enhanced, the contracted volumes of our streams will be enlarged, inviting to their cool banks thousands from crowded cities, who, fishermen in their youth, would gladly continue such in their manhood; the woods will be filled with game, and the instincts which we have inherited from our English ancestors may find indulgence in the manly pastimes of the hunt; and New Hampshire, our own gallant little commonwealth, which leads the list of the immortal thirteen which achieved our national independence, and, as the ninth state to ratify its constitution, set in motion the wheels of our general government, will become the most attractive spot this side of Paradise.

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ber, which at the low price of one shilling the cubic foot, only one half of its present value, will give £1,000 per acre, or, in all, a sum of £6,500,000 sterling."

"In Argyleshire there are probably 40,000 acres of natural coppice wood, which are cut periodically, commonly every nineteen or twenty years, and are understood to return about £1 an acre annually. Very extensive plantations have been formed by the Duke of Argyle and other proprietors. About thirty years ago those of his grace were reckoned to contain 2,000,000 trees, worth then 4s each, amounting to the enormous sum of £400,000."

*If the legislature, which has wasted hundreds and thousands of dollars in useless talk about crows and woodchucks, would turn its attention to the condition and interests of the forests, and establish a state department of forestry in the agricultural college, it would confer a benefit upon its landed interest far surpassing any as yet rendered it. An annual appropriation, one half as large as that for the support of the fish commission, would amply suffice for its maintenance.

A FAMILIAR TALK ABOUT TREES.

BY FRANKLIN B. HOUGH, FORESTRY AGENT, DEPARTMENT OF AGRICULTURE.

[Delivered in the hall of the House of Representatives at a meeting of the New Hampshire Board of Agriculture, held at Concord, N. H., on the evening of June 13, 1883.]

Since being invited, some ten days ago, by your secretary, to attend this meeting, I have been travelling every day, and have had no opportunity for writing, or for making references. I will not therefore attempt to deliver an "address," and must simply attempt to give you, from the abundance of the subject, a familiar talk about trees.

When this country first became known to Europeans, the soil was everywhere, throughout this state, and in all the Atlantic states, and in Canada, covered with forests, until we reach the prairies of the West and the treeless regions of the North. These forests differed greatly in density, and in the kind and value of their timber.

Of course, had these settlers then known all that Europeans now know, or all that we shall hereafter know about forest management, a considerable part of this would have been cleared, in order to make room for agriculture. The parts selected for this purpose would have been the best portions for tillage,—the intervales along the valleys, and the arable portions of the hills and the plains. But the hill-tops and the broken mountain regions, too steep and stony for the plow, and too poor for pasturage, would have been spared. They would have left the forests in the ravines, upon slopes liable to erosion, and upon sands liable to drift. But without this knowledge as to the proper care of woodlands, and without a further thought than

to destroy everything alike, and without reservation, except here and there a wood lot, the country throughout the whole settled portion has been cleared, so that there are now but few large tracts of forest remaining, and the valuable timber has, to a very large extent, been cleared off. Much was burned to get rid of it, without any profit, excepting sometimes from the ashes. Forest fires have been invited in to aid in the destruction, and much that was not absolutely wasted without any return has been extravagantly used in needless degree.

This wanton practice has at length begun to attract the serious attention of thoughtful men in every part of the country, and they are asking one another, What shall we do to be saved from the inconvenience and distress which the extreme depletion of these supplies must occasion?

The great seal of Maine bears the device of a white pine tree, and that of your state the figure of a ship upon the stocks. The first of these emblems fitly represented the grandest element of wealth that the state of Maine then possessed; but it has since disappeared from their commerce almost entirely, and in its place we find them using up their spruces and hard woods, which must in time become equally scarce. The ship on the stocks reminds us of a time when the white oak and the white pine supplied the materials for an industry which was once regarded as of commanding importance, and worthy of adoption as the symbol of a state.

I have recently visited Portsmouth, your only sea-port, and they told me that this business of ship-building has died out almost entirely as a private enterprise, and that excepting what is going on now and then at the navy-yard, there is scarcely anything left. At Bath, the principal ship-building point in Maine, where a considerable number of ships are still built every year, the amount of tonnage is far below the totals of former years. They get their white oak from Virginia and other Southern states; their yellow pine from Georgia; their white pine from Michigan; and some of their "juniper" (tamarack) knees from Canada. They are already getting ready to build iron ships at that place, wisely foreseeing in this, a time not remote, when these timber supplies which they are now using will become scarce.

It is true that coal for fuel and iron for naval and civil constructions have in late years largely taken the place of wood; and to this extent they have lessened the demand for wood as a fuel, and for the heavy timbers formerly used in ship-building and in city architecture. But on the other hand, new uses for wood, in various forms, are daily appearing, and among these is that for the making of paper-pulp, of which, already, since a comparatively recent period, a large amount is made; and of this we have as yet scarcely seen the beginning, although nearly forty establishments exist in the New England states alone. Upon the whole, we may say that the amount of wood consumed as a material is increasing every year, while the existing supplies are as rapidly becoming less. I think it need not be proved, for the fact is evident, that although we may, to a large extent, employ stone, slate, tile, brick, and the metals for many uses in which wood is now taken, we can scarcely conceive of a time when this material from the forests will not be in great and constant demand, or when it could ever be less needed than to-day.

Let us for a moment compare the conditions of this country and of Europe, and especially with respect to the titles to land, and notice some points of difference that vitally concern the prospects of our future forests and our timber supplies. With us, the lands in all the older states, and throughout the settled portions everywhere, belong to private owners. Neither the states, nor the general government, nor any county, city, or town, has any woodlands, nor any land upon which forests could be planted. To make a beginning of public forest management, it would be necessary to obtain the title, either by purchase, gift, or some lapse of title. It is in the most extreme degree improbable that any public authority whatever will ever plant upon private lands, or that any law would be passed, or could be enforced, that should compel the planting of lands by their owners. What remains of our woodlands, as well as all of the land on which the forests once grew, being now held by private owners, it is these owners who must do the planting of the future; and they will clear their lands, or rear forests, as their self-interest leads them.

Now in Europe we find upon the continent very different conditions. The governments, the communes, or other local or-

ganizations, and the public establishments of various kinds, are owners of considerable tracts of forest land, and administrations have been organized to take care of these interests. To get qualified agents for this service they have established schools of forestry. I have visited the forest administrations of every country in Europe that has a system of this kind, and about twenty of these schools, of which there are about thirty. At these schools, young men who have passed their first studies, about equal to what is taught in our academies, are admitted upon examination, and are carefully taught from two to three years in the sciences and the practices that apply to the care of woodlands and the removal and first working of forest products. They are taught mathematics, as applied to surveying, the measurement of contents, estimates of the growth and quantity of timber, accounts, and the like; the natural sciences that have reference to trees, and to all animal or vegetable life that may effect their welfare. Chemistry, geology, meteorology, mechanics, and, in short, whatever branch of knowledge is useful to the forester, including so much of laws and jurisprudence as may be needed in the discharge of his official trusts. Many of these candidates for the forest service are the sons of foresters, and one of the most talented of the professors of forestry in Europe is the son and grandson of men equally eminent in their profession.

The students in these schools have provided for their use extensive collections of tools and implements, models, cabinets of natural history, laboratories, libraries, forest gardens and nurseries, and the like, and every week they make excursions with their professors to learn from actual observation whatever concerns their pursuits. Once in a year they make a long journey to see forests and operations in planting under other conditions, and of these journeys they keep a journal and write up an account. Finally, after passing examinations that show approved attainments, they become entitled to a place, at first under an experienced forester, and afterwards by themselves; and they may rise through the various grades of the service, as in our army and navy, with the right to retire on a pension when working days are over.

Among the foresters' duties in Europe are the protection of

game and the adjustment of rights of common usage, as, for example, where the inhabitants of a commune or village have a right to fuel, or building materials, or pasturage, and the like, upon their common lands. With none of these affairs relating to hunting or common rights shall we in this country ever have concern. The rights of hunting belong absolutely to the owner of the land, and of rights of common usage we have none.

Now in all of these foreign systems we have nothing to learn from their codes or their jurisprudence; but we have everything to learn from their methods of planting and management, and from the scientific researches that are being made abroad. We could not give employment to men who were so highly qualified in these special sciences; we need a less extended but plain and practical course of instruction for a greater number; in fact, more or less of the first principles throughout the whole of our educational system, even down to the primary schools.

Every graduating class in a college should, at least, have the opportunity of hearing a few practical lectures upon forestry, and in several of our colleges, as in Dartmouth, instruction is now given in the class-room. In schools of less degree, it would be a most profitable thing to inculcate correct ideas, if nothing more, as to the importance of our woodlands in the welfare of the country, and the necessity of preventing injuries and avoiding waste.

As we begin to feel the need, we find springing up here and there inquiries under authority of law relating to the wants and the duties of the future, as depending upon the maintenance of our forest supplies. You have a commission named for the purpose in New Hampshire; they have one in Vermont; a little has been done in New York; and through state and local societies, of one kind and another, our people are beginning to turn attention to this subject, and to realize its importance.

It is not alone the want of wood as a material for ship-building, and erections of every kind upon the land, for manufactories and uses of infinite variety and importance, and for fuel, that is reminding us of this duty. We find effects upon our climate, upon the flow of water in our rivers and streams, and upon our agricultural interests everywhere, which may be, directly or indirectly, traced to the destruction of our forests as

a principal cause. Let us briefly notice these several incidental effects, and the manner in which they are produced.

In a wooded country the climate is more humid on account of the great amount of evaporation that is going on from the foliage. The soil is humid because sheltered from the winds and the sun, and the streams are not liable to sudden floods and to drought, because they issue from swamps, or are fed by perennial springs. Let us notice the effect of clearings upon these conditions.

In an open, treeless region, the soil being exposed will sooner dry up after a rain, and if it be clay, it will become hard, so that the rain when it falls will run off at once, instead of sinking into the earth. The water, no longer obstructed by roots and rubbish, does not find its way slowly into the water courses, but, upon steep mountain slopes and hillsides, tends to wear ravines, which sometimes become immense chasms, and the rocks and rubbish carried down by the torrents cover the fertile valleys below with stones and gravel, and spread over the plains in destructive inundations that desolate the country far and wide. Finally, the sediment coming down to the sea forms sandbars at the mouths of the rivers, which cause lagoons and stagnant morasses that render a once healthy and fertile region a pestilential waste.

This picture is a faithful one of great regions in southern Europe, and especially in Italy and Spain. In other countries, as in northern Africa, in Greece, and in western Asia, we find vast solitudes and sandy wastes, now given up to hopeless sterility, which were once well cultivated by a dense population, and abounding in trees and fruits. We find everywhere in our own country that our springs and wells fail in summer, and that mill-streams once furnishing hydraulic power through the year are almost dry for months together. Rivers once navigable are so no more, and streams depended upon for feeding the reservoirs of our city water-works fail. The snows, prevented from drifting in a wooded country, accumulate in drifts behind fences or fill in the ravines, leaving our fields exposed to frost, and our winter grains to great injury and loss. The insectivorous birds are driven away because they find no shelter, and our fruits fail where they were once as sure as the returning seasons.

Now these facts cannot be denied, and they lead us to the all-important question, What shall be done to prevent further injuries, and to restore the conditions that we have lost?

The first thing to be done is to economize—to use less, and waste less. We have coal, and peat, and iron. We can use these, and stone, slate, brick, and tiles, in a great number of places where we now use wood. We can use up the waste products that are now allowed to decay. We can get tanning materials, when our hemlock is exhausted, by planting oaks. We can provide for future wants by reclothing our broken lands everywhere with woodlands, and we shall begin to get the benefits, so far as they concern the climate, as soon as the ground is well shaded, although we may have to wait longer for the material that these woodlands should supply.

In travelling through your state—and it is much the same throughout New England and the Northern states generally—I have had frequent occasion to admire the facility with which an abandoned field will lapse again into a forest. You have none of the difficulties that they encounter as we approach the arid regions of the West in making trees grow. They will grow themselves, and everywhere, if only allowed to remain where they find themselves a chance. But we should bear in mind that some kinds of timber are worth a great deal more than others; that it takes a long time for any trees to become of size suitable for lumber, and that almost always those of least value are of most rapid growth, thus shading out and killing off the more valuable kinds.

Of native species, you have various kinds of oak, ash, elm, birch, maple, linden, beech, chestnut, and others of the deciduous class; and of the evergreens, the pines, spruces, cedars, and the hemlock. It is an easy matter to determine from what has been which of these will thrive to advantage, and it is not worth while to experiment much on uncertainties. We need not try to prove, for this has been done by nature, that the chestnut will not grow on a limestone soil; that pines prefer a sandy soil, if underlaid by a subsoil congenial to their growth; that the maples and the beech avoid the sand and seek calcareous soils; and so on through the whole list.

But besides these native trees, we have within our range of

opportunity many not native that will still thrive exceedingly well, some of them bearing seed and propagating their kind as vigorously as in their native home, and others that will grow well enough if helped to a place, but that do not reproduce readily from seed. In Scotland the larch, a native of Tyrol, has been found much more profitable than any of their indigenous trees. The elm in England thrives exceedingly, although its seeds are seldom fertile, and the most precious tree for planting in the North-Western prairie states in some situations is the white willow, which grows best from cuttings or sprouts.

Of trees not native I would suggest the black walnut, hardy catalpa, European larch, Scotch and Austrian pines, and certain of the European willows and alder as well worthy of experiment. They may prove perfectly well adapted to your soil and climate, and some of them, as for example the willows and the alder, a great deal more profitable than our native species. They will at least prove interesting as affording means for comparison and for botanical study, and add new resources to our list, already large, of trees suited for ornamental plantation in our villages and around our homes.

While speaking of exotic trees, it may be remarked that the conifers of the Pacific coast, which thrive so luxuriantly in their native region, almost uniformly fail in the Atlantic states, while the trees of eastern Asia, the Himalaya region, and Japan, almost uniformly succeed. As these all differ in species, and many of them in genus, from those nearest like them in our own country, we have in these a precious opportunity for increasing an interest in ornamental plantations, and perhaps of adding to our list of exceptionally profitable timber trees.

Let us now come to consider a very practical question, which, at the beginning of your legislative session, may be deemed opportune, namely, How can a state encourage the preservation and restoration of its forests? It is true that individual enterprise, under the stimulus of high prices and the pressure of want, might find it profitable to seek these prices and relieve this want; but our land-owners, upon whom we must depend for future planting, will not begin to do this in a very extensive way until they feel this necessity upon them. It is not wise to wait till these evils are present. It is the part of prudence and

foresight to provide seasonably for this future; and in this the state may render important services to its citizens in various ways short of paying for the expenses of planting, and among these the following:

1. It may exempt waste and vacant lands from taxation for a limited period, where they are successfully replanted and protected for forest growth; or if there be a constitutional provision forbidding the exemption of private property from taxation, as in some of the states, it can declare that the increased value of lands by reason of forest growth shall not be taxed until some revenue begins to accrue.

2. It can stimulate rivalry by the offering of premiums for the greatest amount planted, the best management, or the most approved results in the introduction of exotic species, with reports showing the methods of operation, and other information best calculated for rendering this experience useful to others.

3. It can in like manner reward the authors of essays upon forest culture, and various subjects relating to the maintenance and management of groves and woodlands. To render these most widely useful, they should be printed for distribution among those engaged in planting.

4. It can provide for the establishment of experimental stations for the careful study of methods and the determination of facts of practical utility; and it can aid in this by the distribution of seeds and plants among those willing to coöperate in these observations.

5. It can provide for instruction in the first principles of forestry in the public schools, and to a greater degree in the higher institutions of learning in the state; and in a more general way it can enable agricultural, horticultural, and other societies to extend their operations in the discussion of subjects relating to forestry until special societies for this purpose are established.

6. It can provide laws for the prevention and control of forest fires, under which greater care would be taken in the use of fires in or near a woodland, and a more direct responsibility attached to this act.

7. In some of the states where this has not been done, the state can enact laws compelling the owners of cattle to keep them within their own premises, thus removing one of the mo-

tives for setting forest fires, and tending to the welfare of the woodlands generally.

It is very generally observed that in a new country, and in the absence of an owner or his agent, the rights of property in timber are often disregarded, and it has been appropriated for use without much care or inquiry as to who the owner was. This is especially true with respect to timber upon the public domain, and upon railroad grants. But where groves are planted upon the lands of a resident owner or manager, there would be no greater liability to trespass than in a corn-field or an orchard. As a country becomes older, these private rights become better established. The hardy and sometimes lawless pioneer moves on with the advancing tide of civilization, and personal rights become better defined.

I might say much more that the opportunity allows concerning the amenities of life that are secured in home adornment, village improvement, and city parks, which are so many forms of planting and cultivation, in which the benefits appear in the public health and in the intellectual refinement and personal enjoyment which they secure to all who come within their influences.

We are accused by Europeans of being an unstable and restless people, having no strong attachments to ancestral possessions, and ever seeking new fields of enterprise in an uneasy desire for change. There is nothing that can more strengthen this attachment to home and country than by making them pleasant. It is only those who feel this attachment, that build monuments and that found institutions that will survive them as witnesses of their substantial interest in the welfare of the country in which they have lived.

I have faith in the Yankee! I believe in him! If you can only tell him where there is a dollar to be made or saved, *and make him believe it*, he will find the means to secure it. Now one of the ways of doing this is to plant trees. When planted, protect them. Teach the importance of this, and the methods by which it can be done to most profit, in your schools and colleges, and especially let every owner of land seek to advance this object, both by precept and example, and it will not be long before we shall begin to realize the advantages that should result from this measure.

CLIMATIC EFFECTS OF FORESTS.*

The forests exercise in many ways an influence upon the climate, but to understand this we must define what we understand by *climate*.

The climate of a country, according to M. Humboldt, is the combination of calorific, aqueous, luminous, aerial, electrical, and other phenomena, which fix upon a country a definite meteorological character that may be different from that of another country under the same latitude and with the same geological conditions. According as one or another of these phenomena predominate we call the climate warm, cold, or temperate, dry or humid, calm or windy.

We always regard heat as exercising the greatest influence, and after this the amount of water falling in different seasons of the year, the humidity or dryness of the air, prevailing winds, number and distribution of storms through the year, clearness or cloudiness of the sky, the nature of the soil and the vegetation which covers it, and according as it is natural or the result of cultivation. The following questions arise for consideration:

1. What is the part that forests play as a shelter against the winds, or as a means of retarding the evaporation of rain-water?

2. What influences do the forests exert, through the absorption of their roots or the evaporation of their leaves, in modifying the hygrometrical condition of the surrounding atmosphere?

3. How do they modify the temperatures of a country?

4. Do the forests exercise an influence upon the amount of

*Extracts from a paper by Mons. A. C. Becquerel, late member of the French Academy of Science, who recently died at the age of ninety years. It has been furnished, translated, in Dr. F. B. Hough's Second Report on Forestry.

water falling, and upon the distribution of rains through the year, as well as upon the regulation of running waters and springs?

5. In what manner do they intervene in the preservation of mountains and slopes?

6. Do the forests serve to draw from storm-clouds their electricity, and by thus doing diminish their effects upon the neighboring regions not wooded?

7. What is the nature of the influence that they may be able to exercise upon the public health?

From these questions we may see what questions we must solve before being able to decide as to the influence that the clearing off of woodlands may exercise upon the climate of a country. First of all, we should know the geographical position of the given country, its geological condition, its latitude, its proximity to or distance from the sea, the nature of its soil and subsoil, as whether pervious or impervious, calcareous or argillaceous. All these embrace elements that we must take into consideration. These questions cannot be solved *a priori*, and, with some exceptions, they demand a particular examination, special study and experiments, without which we run the risk of expressing opinions not in accordance with those of other scientific men, who, being placed at another point of view, may have taken but a part of the question. We will now proceed to give our proofs:

The action of the forests upon the climate of a country is very complex, for it depends:

(1) On the extent, elevation, and nature of the soil and subsoil;

(2) On the aspect, in its relation to warm or cold, or to damp or dry winds;

(3) On the age since cutting, and upon the species, as whether of evergreen or deciduous kinds, since the radiating and evaporating power are not the same at all seasons;

(4) As to whether the rainy season comes in summer, autumn, or winter; and

(5) The proximity of pestilential marshes, &c.

Whatever the effects of a forest may be, we may assume that it is proportioned to its extent; for a tree or a clump of trees

cannot have as much effect as a great mass of woodland. A single tree indicates by its shadow on the ground near it that its presence is injurious to the cultivation of plants within a certain distance, depending upon its height. The higher a forest grows the greater this shadow extends, and thus the effect is felt within a certain limit in its borders and to some distance beyond.

The height of the trees (if the forest has a certain density) may afford an obstacle to the winds of greater or less extent, according to the slope of the surface and the relation which this bears to the direction of these winds. It is well understood that the forests do not afford any considerable shelter except against the lower winds, and the obliquity of these must be taken into consideration, as we shall hereafter see. Their density, up to a certain point, supplies the place of a solid mass, as we shall further on more fully show.

The nature of the soil may vary, as follows:

It may be silicio-argillaceous, silicio-calcareous, or argillo-calcareous, and the subsoil may be permeable or impermeable. The effects are very different in these various conditions. We may classify these various conditions of the soil as follows:

Pervious soil { 1. Subsoil pervious. 2. Subsoil impervious.

Impervious soil { 1. Subsoil pervious. 2. Subsoil impervious.

The roots of trees penetrating the soil and the subsoil separate these parts and facilitate the flow of waters that may fall upon the surface, and the older the woods, and the greater the number of old reserves, the deeper do the roots penetrate into the soil, and the easier do the waters pass down. Let us examine the effects of these four divisions of the soil that we have mentioned, upon forest vegetation:

1. With a pervious soil and subsoil, the waters are never stagnant, whether the ground is wooded or not.

2. With a pervious soil and an impervious subsoil, there is a stagnation of waters if in an open country, as in La Brenne and Sologne. In a wooded country, and the subsoil has not too much depth, the waters drain off easily by means of the roots that traverse it; but if not they remain stagnant.

3. If the soil is impervious and the subsoil pervious, it will not agree with certain trees, except the oak.

4. If both soil and subsoil are impervious, it is least of all suited for forest culture: nevertheless there are certain kinds of trees that will live and thrive in these conditions. The roots of trees penetrating into the soil have an effect in modifying the distribution of the waters of a country. MM. Gras and Alphonse Surel, from numerous observations made in the Hautes-Alpes, have explained the manner that forests operate when planted on the slopes of mountains. When the soil on the slope is overgrown by vegetation, first of low plants and then by trees, the roots interlacing among one another form a net-work, which gives consistence to the soil. The branches covered with leaves secure it against the force of the rains; the trunks, the shoots, and the brush which cover the ground oppose multiplied resistances to the currents, which without this check would wear gullies into the soil. The effect of vegetation is, therefore, to give more solidity to the ground, and to divide the waters over the whole surface. The soil being divided by the roots and covered by a spongy humus, absorbs a part of the waters, and thus hinders them from running off from the surface. The woods, therefore, serve as a shelter against the rains in a mountainous country.

The action of the forests as a shelter against the winds is not absolute, for these effects depend upon the height at which the wind blows. If this height is less than that of the forest, the wind is stopped at every moment by the trees; it loses its velocity, and if the woodland is of sufficient extent it stops it altogether when it has reached its limit. But when the wind blows at a greater height than the trees, the latter have no effect except upon the lower current, at least if its direction is not declined. Above the reach of the forest the upper mass of air, meeting no obstacle, continues its horizontal course with undiminished velocity. The action of a forest upon the wind is therefore limited as regards the shelter it affords.

Forests may operate in two other ways. When found in the way of a current of air moving with violence, and at the maximum point of saturation with vapor, a part of it penetrates the mass, and a part is turned off by the obstacles that it meets in

the passage. The higher portion, if it meets a stratum of cool air, has its vapor precipitated, and it falls as rain.

When a current of bad air, laden with pestilential miasms, penetrates a forest of a certain extent, it is wholly deprived of these properties. The effect of this is observed in the Pontine marshes, in which a belt of trees preserves all that is behind them, while the uncovered part is exposed to fevers. The trees, therefore, tame the infected air, and deprive it of its miasms.

There exist in Algeria three classes of trees: the first, of deciduous trees, such as the poplars, alders, &c., which grow in the ravines and on the banks of streams; secondly, the agaves, cactuses, and palms; and, thirdly, trees with evergreen leaves, such as olives, caroub-trees, laurels, &c. M. Hardy has noticed that trees of the first group, that are natives, grow more in breadth than in height, with constantly a broad, flat top. If it happens that some of them come to a large size, and find conditions more favorable for their development, they grow vigorously for a time, when, on coming to the height of the trees around them, the top dries up, and the branches spread only in a horizontal direction. This was seen in some poplars planted at Bouffarich, in the middle of the plain of Mitidja, in humid conditions that left nothing to be desired for this species, yet these trees could not get more than ten or twelve meters high. We often, however, observed specimens that, nevertheless, did not appear to suffer at the top; but they grew at the base of a steep hill, of which the top was much higher than the trees.

This inability of vegetation to rise above a certain height, much below that at which the tops of these trees commonly stop gaining in altitude, evidently shows that, at an elevation greater or less, there exists a stratum of air where further gain in height is impossible. This effect should be ascribed to the atmospheric currents from the desert, which are hot and dry; and all trees growing in Algeria yield to its influence. Trees of the third group, the cypresses and cedars, brave this influence and grow to a greater height.

The principles we have stated serve to show the part that forests play as a shelter, and the limits to which this effect extends.

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M. Arago says with reason that the forests serve as a shelter against winds, but he has not said within what limits; yet the whole question rests there, as we will see. The Alps, by reason of their location and height, shelter certain parts of the Mediterranean coast against the cold north winds, especially such places as Nice and Hyeres. This same chain of mountains gives an exceptional clime to Lake Maggiore and Lake Como, and the region about them. Nothing of this would appear, or at least to no great extent, if the Alps were not several thousand meters high. Had they been only common mountains, or only as high as common hills, the case would have been different, for the protected places, as we shall see, depend on the heights of the mountains. Well, the action of the forests composed of trees of the first rank, and not less than 30 to 40 meters high at most, ought not to be different from that of simple hills. Their mass is virtually alike.

In the valley of the Rhone, where the mistrals often blow, a simple hedge two meters high will shelter to a distance of twenty-two meters, which is a limit that should serve as a guide for calculation. It is by means of such shelters, very abundantly grown in this valley, that they are able to cultivate vegetables that could not be raised without this aid.

In the open plains of Provence they raise higher hedges by planting cypress and laurel. All shelters of little elevation preserve wide spaces, when the cold lower winds blow horizontally.

We should not forget to mention the different aspects which the two slopes of the Pyrenees present—on the side of Spain exposed to the south winds, arid, while on the north, toward France, covered with pasturage and a fine vegetation.

The examples that we have cited suffice to show that the action of forests, even in trees of the first size, is limited, and cannot therefore extend to whole regions of country.

Schubler has proved that all soils do not possess in the same degree the property of absorption. In 100 parts of soil dried at 40° or 50° he found the quantity of water absorbed to be as follows:

Silicious sand	25
Gypseous soil	27

Calcareous sand	29
Barren clay	40
Fertile clay	50
Loamy clay	60
Pure clay	70
Fine calcareous soil	85
Humus	190
Magnesian soil	156
Garden soil	89

The calcareous and silicious sands are therefore the substances that have the least affinity for water, while humus has the greatest. The state of division in like manner has its influence, as we see in fine calcareous soil.

We cannot separate in this actual case the property of absorption from that of aptitude for drying, which we must take into account in evaporation. Experience proves that 100 parts of water in saturated soil lost in four hours, at 13°.75 of temperature, the following proportions:

Silicious sand	88.0
Calcareous sand	75.9
Barren clay	52.0
Rich clay	45.7
Clayey soil	34.9
Calcareous soil, finely powdered	28.6
Humus	20.15

We see, therefore, that silicious sand is a substance that allows the water to escape most easily, while humus is one that retains it for the longest time. Calcareous sand loses water more easily than silicious sand.

We will further mention the results obtained by experiments of Melloni, relative to the cooling that results in certain substances exposed to nocturnal radiation, and which should be taken into the account:

Substances.	Relation in cooling effect.
Plants of close leaves	103
Silicious sands	103
Vegetable soil	92

But the absorbing power being equal to that of emission, we should admit that substances within the same time should warm

in the same ratio. Such are the elements that enter into the solution of the question.

When the rain falls upon the soil, the upper strata begin by becoming saturated. Then the excess of water passes to the next lower strata, and they also become saturated, and this continues until the excess above has fully saturated the parts of the soil below.

When the upper bed dries from the evaporation into the air, it retakes from that below what it has lost, and this from the next below, until all the water originally absorbed is dissipated.

As for the evaporation, it is manifestly less, all things being equal, on wooded soil, than on a soil covered with turf. On the other hand, the Count de Gasparin, who has made some experiments upon this subject, has found, in comparing the evaporation of a surface of water with that of a surface of soil completely saturated, in August, and at a mean temperature of 23 to 26 degrees, the following relations one to the other:

	Evaporation from water.	Evaporation from soil.
First day	15.0	4.1
Second day	13.7	2.5
Third day	11.5	1.8
Fourth day	12.0	1.3
Fifth day	11.7	1.3
Sixth day	11.0	1.2
Seventh day	9.4	1.3

The evaporation, therefore, goes on rapidly at first from the soil, and then becomes very slow.

The series of experiments that we report show that the evaporation should vary considerably according to the nature and physical condition of the soil, a consideration to which we have not had regard. Thus soils covered with low vegetation or with woods, and in which the soil is composed of humus, mingled with sand and lime, or clay, absorbed more water than those which contain no humus, and consequently retain it longer than the latter. These effects vary according to the proportions of the various elements of which the soils are composed. The infiltrations are greater in wooded lands than in those covered with sod. The roots penetrate deeper, and thus facilitate the

passage of waters which would only be stopped by an impervious stratum.

The branches of trees in leaf not only oppose the evaporation of the water in the soil, but the leaves themselves are constantly yielding a vapor from exhalation, and which tends to reduce the evaporation of waters, so far as the moisture exhaled goes to saturate the air, the infiltration at the same time going on into the soil. Herbaceous plants not in masses do not produce similar effects; in fact, whoever has been in places partly wooded and partly sodded must have observed after a rain and a rest of some duration that the sodded grounds were dry while the wooded soil was always damp.

We will now speak of the water absorbed by the roots, and that which is exhaled into the atmosphere.

The roots of trees, as shown by the experiments of Hales, Dutrochet, Mirbel, and Chevreul, absorb a large amount of water charged with various elements constituting the sap. The surplus water is evaporated from the leaves, which are constantly surrounded by a humid atmosphere. The water thus evaporated is drawn not only from the upper strata, but likewise from the deeper layers of the soil into which the roots penetrate, and which supply little or no water to herbaceous vegetation. These lower strata are fed by subterranean sheets of water that often come from a distance. Furthermore, this water remaining in these lower strata, being thus given to the atmosphere, falls again as fog, dew, or rain, and thus increases the quantity of water that the surface of the soil receives from some distance away.

The amount of water absorbed by the roots is so great that it is practically difficult to make much of it remain near the trees, several reasons for preventing it occurring. The soil in contact with the roots, and for a little distance away, is in a certain state of desiccation, little by little it loses its nutritive properties, the lime, &c., and when these elements are gone, the soil contains little but sand and clay, which then becomes more permeable. It is, therefore, well demonstrated—

(1) That a difference exists between the evaporation from a naked soil, and a soil covered with sod.

(2) That there is a like difference between a soil covered

with sod and one that is wooded, with the further advantage of the latter in facilitating the infiltration of water.

(3) That the amount of water absorbed by the roots does not produce drought in the soil, since it is returned after evaporation in the condition of fog, dew, or rain. The drought does not take place till the soil is exhausted.

Let us now see to what extent the conclusion of M. Beugnot is well founded, that the clearing of the woods is never injurious to health. This conclusion is true if the soil is siliceous or calcareous, and the subsoil permeable; but it is not if either one or the other of these is argillaceous, because in this the roots are no longer able to facilitate infiltration, as we see in Sologne, la Brenne, and la Dombes, which cannot generally be drained except by drawing off their stagnant waters. It is the same if the woods are cleared in the vicinity of pestilential miasms, as the Pontine marshes.

Let us now pass to consider the thermal influence of forests. This influence has been established by Humboldt, and the meteorologists, as follows:

They shelter the soil against the sun's rays; they maintain it in a greater degree of humidity, and facilitate the decomposition of the leaves and litter, which they change into humus; and they act as a cooling cause, by producing active aqueous transpiration from the leaves and by multiplying in the expansion of their branches the surfaces warmed by the solar heat, and the surfaces cooled by nocturnal radiation. In regard to the action last mentioned, positive experiments show that the layer of atmosphere in contact with a meadow, or a field covered with herbage or vegetable leaves, becomes cooled, by nocturnal radiation, other things being equal, several degrees—sometimes as many as 6, 7, or 8 centigrade—below the temperature of the atmosphere at some meters above, while nothing of this kind takes place over a naked soil, which becomes warm or cool according to the nature of its component parts. We will add, as we have demonstrated, that the leaves as well as the trunk and branches become warmed by solar heat, and retain into the night a portion of this acquired heat. This effect should counterbalance the cooling from nocturnal radiation. We have not, thus far, taken account of the fact that the warm-

ing of the trees by the sun has a considerable effect upon the temperature of the atmosphere outside of the woods, as well as within them.

To explain the thermal influence of the trees upon the temperature of the air, it will be proper to unite with some old observations others that we have made upon the temperature of the air at different heights, near and at the surface of the trees. Messrs. Humboldt and Bonpland, in sleeping on the grass during the clear tropical nights on the plains of Venezuela and the lower Orinoco, experienced a damp coolness, while the atmosphere one or two meters above them had a temperature of 26 to 27 degrees of the centigrade scale. Within the equatorial and tropical regions, where the nocturnal radiation operates with the greatest force by reason of the serene sky, the increase of temperature as we rise above the soil becomes evident, as in the middle latitudes, but in much higher degree. We therefore do not observe in the torrid zone any change in vegetation from sea-level to a height of 600 meters, and from that level to 1,200 meters we still retain the flora of the tropics.

We may now explain why, in our latitudes, certain kinds of cultivation cannot be had in valleys while they succeed upon the hills, and the reasons why vegetation may be touched by frost in the low grounds while it is not at higher elevations. M. Martins has noticed a fact of this kind in the botanical garden at Montpelier, where the laurels, figs, and olives perished in all the low grounds in the botanical gardens, while they were spared at some meters of higher level, the conditions as to shelter being just the same, and there being no other differences than altitude. Do we not likewise know that vines growing on the hills yield better wine than those on the flats, and the reasons why they ripen their fruits more completely?

The experiments we have made with the electric thermometer bring the evidence of this fact strongly to light. The temperature of the atmosphere rises from $1^m.33$ above the ground to $21^m.25$ at the top of a horse-chestnut tree, and probably to a certain height above, the distance of which limit has been fixed by M. Martins and other meteorologists; for the leafy covering of the trees should have the same effect as the soil covered with low vegetation, by reason of its great absorbing and evaporat-

ing power. The mean differences between the temperatures of the two stations have been determined at the Jardin des Plantes, during several years, as follows:

From 1^{m}.33 to 16 meters.....0°.420 (C.)
From 16 meters to 21^{m}.25.....0°580

We therefore see the effect which low vegetation and the foliage of trees exert upon the temperature of the ambient air, through the influence of the radiation of heat. We will now inquire as to which it may be, with regard to the body of the trees—that is to say, the trunk and branches. All bodies, and trees the same as other bodies, become cool or warm, according to the air around them, and participate to greater or less extent in the variations of temperature of the ambient air. The effects produced depend on the state of the surface of bodies, its conducting powers, and specific heat. The experiments leading to these results are described in several memoirs which we have presented to the Academy of Sciences, and furnish the most convincing proofs. The following are some of the results observed:

In seeking to find the variations of temperature within a maple of 0^{m}.4 (15¾ inches) in diameter in the midst of a mass of trees, it was found that during the months of August, September, and October, the average temperatures did not vary sensibly from that of the air in September, although the range in variation was scarcely half as great within the tree as in the air.

The temperature within the tree was far from being the same in every part. If the leaves and branches put themselves promptly in equilibrium with the temperature of the air, the trunk did not delay to do the same to a depth of 0^{m}.1 (about 4 inches). These effects are different in trees exposed to the sun, and according as these are near to or far from objects that absorb and radiate heat. Near a wall 2 meters thick a plum-tree was growing, 6 meters high and .35 in diameter, and covered with leaves and fruit in July. The difference between maximum and minimum was in some days from 24° to 25° (C.), and the temperature within the tree arose to 37°. Such a condition could not exist long without enfeebling the tree, and as a consequence its leaves perished little by little, its fruits fell,

and everything appeared to indicate the approach of death, which came a month later, and was caused by what gardeners call a "*coup de chaleur*" (stroke of heat).

We see, therefore, that a tree warms itself in the air, like any inert body, and the more rapidly according as its body is of less volume and its bark of greater absorbing power. It is also true that, having surrounded the trunk of a plum-tree, to the height of 2 meters, with a covering of tinned iron, which has a great reflecting power, the temperature of the air being generally the same as before, the difference between the maximum and the minimum went down from 13°.07 to 5°.2 (C.). We see from this that the temperature of the plum-tree had become more uniform. Upon taking off this covering the difference between maximum and minimum increased and became as great as before. Coverings of metals, or of straw, diminish the variations of temperature within the tree, and render the changes of heat more regular, and we may conceive that the nature and thickness of the bark ought to exercise a great influence upon the warming of trees. Some experiments made upon the *Opuntia*, and other plants, tend to show that the leaves and small branches speedily acquire the temperatures of the surrounding air.

Upon comparing the mean temperature of the air with that of the interior of a horse-chestnut, 0.5 meter (19.68 inches) in diameter, it was found that the mean of the temperature observed within the tree during thirteen months exceeded by 0°.36 (C.) that of the air at its surface, and by 0°.83 of the air on the north side and in the shade, a difference due probably to the fact that the thermometer was placed in a situation sheltered from the sun, while the tree was protected from the north winds by buildings adjacent, and was at the same time exposed to the solar rays. Some experiments made upon other trees established well the principle of the changing equilibrium of temperature, after more or less time, between the air and the trees, and the more rapidly as the variations of the air are less frequent. The difference in autumn and in winter is at its minimum, and in spring and in summer at its maximum.

The maximum temperature of the atmosphere takes place, according to season, between two and three o'clock in the afternoon, while in the tree it does not become manifest until after

sundown. If we notice the effects of seasons, we find that it is especially in summer that the maximum is more marked, and then it is reached about nine o'clock in the evening.

The heat disengaged within the organs and tissues of vegetables does not affect, or but very slightly, the temperatures in which they are placed, and we must seek the principal causes of these changes in solar radiation and the temperature of the air. The diurnal variations of temperature in the air are easily determined, since this is the difference between the maximum and minimum of the day. But it is very difficult to find this variation in a tree, and we may arrive at this in a manner more or less approximately.

Observations upon temperature were made at Geneva from 1796 to 1800, at sunrise and sunset, and at two o'clock in the afternoon, in the air open to the north, and in a horse-chestnut of 0.6 meter (23.62 inches) in diameter. The maxima and the minima may be had by combining the temperatures at two o'clock and those of sunrise and sunset, the maximum taking place, as we have already shown, near or a little after sunset, and the minimum at about sunrise. The difference will give essentially the variations within the tree. By discussing the variations thus obtained in the air and in the tree, it is seen that in the years 1796, 1797, and 1798, the variations were, on the average, five time greater in the air than in the tree.

From observations made at the Jardin des Plantes from December, 1858, to July, 1859, it was found that the mean variations of temperature in the air and in the tree are in the ratio of 3.80 to 0.81; that is to say, they are 4.7 times greater in the air than in the tree, instead of being 5.89 times, as found at Geneva. This difference is evidently due to the poor conductability of the wood, which does not allow the changes of temperature in the air to be conveyed rapidly into the tree. We find, in fact, that very decided changes, but of short duration, are noticed in the air, which cannot be appreciated in the tree.

The leaves and young green branches of the trees and the low plants that cover the meadows are in similar conditions as to warming or cooling, and produce like effects in radiation. It is therefore only in branches of a certain size, and in the trunks, that we can study the influence that the temperature of vegeta-

bles properly exerts upon the temperature of the ambient air. We may practically consider a green stem as a body covered with an envelope that possesses great emissive and absorbent power, by virtue of which its temperature is lowered or raised continually from the effect of celestial radiation on solar heat; but when the parenchymatous tissue is replaced by a cortical one, the wood within being damp and a poor conductor of heat, either in a transverse or a longitudinal direction, the movement of the heat then operates but slowly, and we no longer observe in the interior those rapid changes of temperature noticed in the young branches. We see, therefore, that the variations are much less in the trunk of a tree of certain volume than in the air. If the temperature of the air varies within extended limits but of short duration, the thermal condition of the tree is but little affected. If the changes, however, are moderate in extent, and of long period, the tree finally acquires the temperature of the air.

Every vegetable needs a certain degree of heat to enable its organs to act. If the temperature rises gradually, the parts dilate, and evaporation and the circulation of the sap are accelerated; if the temperature is lowered, the opposite effects are produced. On the other hand, alternations of heat and cold give a new activity to vegetation. But the great variations of temperature within the tropics, between day and night, in the portions of the air that envelop the trees, become likewise manifested within the interior of the trees, and afford conditions that eminently favor forest vegetation.

The atmosphere is, therefore, the source from whence all vegetables derive the heat which their being requires for developing and accomplishing all the phases of their existence. The mean temperature of a place, and the daily variations and extremes of temperature in the air, are, therefore, the caloric elements that we are principally to take into account in the phenomena of vegetable life, and in researches relating to this vegetable life, and to the thermal influences of forests, and effects of woodlands generally upon the climate. Whatever heat may be generated in the tissues where the transformation of the sap takes place does not materially affect their temperature—at least it is not appreciable by our instruments, and whatever it may be it is

dissipated. We have undertaken several series of observations upon temperature in different localities, within the woods and without, and to a certain distance from them, in order to determine the influence that the forests exercise upon the mean temperature. The results obtained will be made the subject of another memoir.

We now come to remark that vegetables possess within themselves the power of resisting, for a certain time, an extreme reduction of temperature without suffering organic lesions, as we have proved in a series of experiments that leave no room for doubt upon this point. We have, from this, been led to think that there exists in vegetable organisms an independent cause of conductability, which operates against this cooling to a degree below the freezing-point, and preserves them for a certain time against the disastrous effects of severe cold. This action varies according to the diameter of the tree, and probably according to the species to which it belongs.

In northern regions, the temperature of plants, as compared with that of the air, is more remarkable. M. Bourgeaud, in 58° of latitude, in places where the temperature goes down to the congealing point of mercury, or to —40° (C.), observed the following facts:

1. The *Populus balsamifera* and *Abies alba* were observed during the eight months from November, 1857, to June, 1858, at nine o'clock in the morning—the time of day when he supposed the temperature to be at about the average of the day—the mean temperatures of the air and of the poplar were the same,—agreeing in this with the observations of which we have above spoken, and going to establish the principle by virtue of which the temperature of the plants tends constantly to become that of the ambient air, notwithstanding the causes tending constantly to increase or diminish this effect.

2. The monthly temperatures presented little difference in the trees and in the air, although they differed very greatly in their maxima and minima. In the month of January, for example, the maximum and minimum of the air were +6° and —34°.6 (C.), while in the poplar they were —2°.2 and 29°.7.

3. During the eight months of observation the mean temperature of the soil at 0.913 and at 0.609 meters' depth was twice greater than in the air.

The thaw commonly comes in May; spring begins at once, and very soon afterward the summer is come. The vegetation is so rapid that cereals sown in this month are harvested toward the end of July; the blossoms on the poplars appear when the temperature of the air is at +13°.47 (C.), while the frost is still in the ground to a depth of $0^m.609$ to $0^m.913$ (23.62 to 35.85 inches). The leaves appear on the first days in June, when the roots are still in a soil at the freezing temperature, the effects being the same as are produced when we bury in a warm bed of soil the tops of vines while their roots are still in the open air. The buds, and even the leaves, begin to develop while it freezes from —8° to —10° (C.). We have here a new evidence of the influence of the temperature of the air upon the trees, even while the roots are in the frozen soil, in promoting and developing vegetation.

The *Populus balsamifera* and the *Abies alba*, as well as other species, are exposed to a cold of —40° (C.) without suffering in their organization; yet the roots of these trees find themselves in strata of earth that are not sensibly touched by the frost, thus affording a new proof that there exists a certain resistance to the cold at the extreme minima of the air, —34°.6 (C.), while in the poplar it is but —29°.7, and that the temperature in a tree may be twice as great as in the open air.

Having shown the relations that exist between the temperature of the air and its variations and those of plants, there remains to be shown what is the temperature of the air above that of trees of the first magnitude, such as the horse-chestnut, 21.25 meters high, at the top of which is placed one of the poles of an electric thermometer in contact with the leaves. It is shown, from multiplied observations, that the temperature of the air over the horse-chestnut depends chiefly on the thermal condition of the leaves and branches, which more or less warm or cool the ambient air, according as they are more or less exposed at the time to the solar rays or to nocturnal radiation.

It should therefore be found, as already remarked, that a tree, with its trunk, branches, and leaves, becomes warm or cool, like any other bodies immersed in the air, according as the sun is above or below the horizon. In the first they are warmed by the solar rays, and in the second they are cooled by the radia-

tions of the night, until the tree is brought to an equilibrium of temperature with the air around it. The cooling of the night then begins, and if the sky is clear of clouds, it goes on in degree proportioned to the amount of cooling of the upper branches and the leaves, which gradually lose their heat by radiations into space. We may see from this how the strata of air that envelop the tree maintain, during a great part of the night, a temperature higher than that of the air which is some distance off.

A tree which has been warmed by the effect of the sun's rays acts in turn by warming the air around it, and when it comes to rain suddenly, the temperature of the air becomes reduced, notwithstanding, at some distance around.

We will cite an instance: On the 9th of May, at one o'clock, after a strong electrical insolation, we had the following conditions:

Temperature above a horse-chestnut	19°.4 (C.)
Temperature to a little distance	18 .3
Difference	1 .1

Half an hour after a rain fell, and the temperatures changed as follows:

Temperature above the horse-chestnut	17°.5 (C.)
Temperature around	15 .2
Difference	2 .3

Here, within an interval of half an hour, the atmosphere that surrounded the tree had therefore cooled but 1°.9, while at a little distance away it had cooled 3°.1, so that the tree must have radiated heat in order to have warmed the surrounding air. The sun having reappeared some moments after, the temperature arose at both points of observation, but a little less over the horse-chestnut than at some distance from it, and at three o'clock these temperatures were as follows:

Above the tree	20°.8 (C.)
At a little distance	19 .2
Difference	1 .6

To get an idea of the warming of the air from the presence of the leaves, we will take as an example the temperature of the atmosphere in July, 1863, at nine o'clock in the morning, at three o'clock P. M., and at nine in the evening. They gave as monthly means as follows:

At 9 o'clock in the morning	21°.56 (C.)
At 3 o'clock in the afternoon	26 .76
At 9 o'clock in the evening	19 .20

We observe that the temperature of the air was at at its maximum at three o'clock, and that it diminished about a quarter of this number of degrees by nine o'clock in the evening. The diminution of the internal heat of the trunks and branches continued to restore by radiation the losses sustained by the leaves in radiating their heat during the night, until 6 o'clock in the morning, when the temperature is the same at 1.33 meters from the ground on the north, and at 16 meters above the ground on the south, and at 21.25 meters at the tree-tops. At this time the celestial radiation ceased to predominate, and there was an equilibrium between the effects of radiation between the earth and sky. In July, 1864, we found,—

At 9 o'clock in the morning	21°.04 (C.)
At 3 o'clock in the afternoon	25 .94
At 9 o'clock in the evening	19 .00

The cooling continued until 6 o'clock in the morning, when the temperature was the same at 1.33 meters above the ground on the north, at 16 metres on the south, where it was 15°.5 (C.)

Taking the month of January in 1863 and in 1864, we had,—

	1863.	1864.
At 9 o'clock in the morning	4°.57 (C.)	—0°.05 (C.)
At 3 o'clock in the afternoon	7 .41	+3 .30
At 9 o'clock in the evening	5 .13	0 .00
At 6 o'clock in the morning	3 .19	—1 .08

We see, therefore, that whether we take trees covered with foliage, or deprived of their leaves, the heat acquired during the day diminishes till six o'clock in the morning.

It is now well proved that the radiations of heat acquired

from the sun's rays warm, and that celestial radiations cool, the adjacent air, a faculty which we did not suppose that they possessed, because we supposed that the evaporation from the leaves was always a cooling process. It may intervene to modify the effect, but it is not a dominating cause. This question will be taken up for further consideration in a future paper.

The experiments above mentioned were made upon isolated trees, but the results were the same in groups of trees which sheltered one another, so as to present an obstacle to the direct action of the sun, with the exception that the temperature of the trunk did not increase so much, other things being equal, as when the tree stood alone.

Forests, groves, and groups of trees ought practically to show the same results as the horse-chestnut, excepting that the effects of the heat, of which we have spoken, should vary according to the height of the trees, the spread of their branches, and the amount of leaves with which they were covered. What conclusions can we draw from these facts as to the influence of forests upon the local climate? We will refer to this subject in a future memoir, but will here remark that we should take into account the nature of the soil, as whether dry or moist, the greater or less facility with which the air circulates, the exposure, and other circumstances not now well understood, and which may vary according to locality. But as the woods, by radiating the heat acquired from the sun, may warm the ambient air, and as this air may be cooled by nocturnal radiations, ought we not to believe that the air they warmed should cause during the night a double current—the former of the warmed air upward, and the other of the cooled air toward the ground? The warm air, being carried by lateral currents, should ameliorate the temperature of the surrounding parts.

Within the tropics, and especially under the equator, where the sun's rays act with greatest power, and are least inclined, the trees ought to produce in high degree the effects of which we come to speak, and which should be felt in the strata of air of neighboring parts. On the other hand, the radiations of the night, which are very great under a sky almost always clear, should act powerfully in hastening the cooling of the leaves.

The following fact illustrates, to a certain degree, the heat

that may be emitted by the woods when warmed by solar radiation. Every one knows that during the intense heat of summer, in the middle of the day, we may feel an oppressive heat in the woods. We may attribute it simply to the absence of currents of air, and this may be true to a certain point, but this appears to be the cause of this warming,—when the branches and leaves, becoming warm, become so many radiators of heat.

We will now explain the mode of influence by which trees affect the temperature of the air around their trunks and branches, and may be able from this to draw the conclusion that the mean temperature of a place may be ameliorated by this cause. To aid in the solution of this question, it will be necessary to consult observations upon temperature made in places wooded and cleared, under the same latitudes, with the same geological conditions, and at the same height above sea-level.

We will pass to observations that inspire more confidence, such as those discussed by M. Boussingault, and made by him and Humboldt, and by Roulin, Rivero, and others, in localities between 11° N. and 5° S. latitude, where the celestial radiations act with full effect.

The mean temperature, on account of its small variations in the course of the year, is shown directly by that of the earth in the shade at 3 decimeters (11.8 inches) below the surface.

Observations show that the temperature of the torrid zone varies from 26°.5 to 28°.4 (centigrade), and that the abundance of forests and the humidity have a tendency to cool the climate, while dryness and aridity would have the opposite effect. These effects are observed at different heights on the Cordilleras, where the temperatures of middle latitudes occur.

Shall we inquire whether it is the same in localities wooded and not wooded, without the tropics, where, the mean temperatures being the same, the means of summer and of winter are different? No observations have yet been made upon this point. Former and subsequent observations tend to show, on the contrary, that clearing over a great area does not sensibly change the mean temperature.

Humboldt collected a large number of thermometric observations made at different points in North America, for the purpose of learning whether the mean temperatures had changed in a

course of years. He remarks that he had records for sixty-three years (1771 to 1834), and returns from thirty-five military posts at which the thermometer had been observed, from the southern point of Florida at 24° 35′ of latitude, to Council Bluffs on the Missouri, and from a study of these records he arrived at the following conclusions:

These observations tend to show, contrary to the opinion very generally received, that since the first settlement of Europeans in Pennsylvania and Virginia the climate has not become more uniform, more mild in winter or cooler in summer, either this side of or beyond the Alleghenies, in consequence of the great number of forests. We cannot, however, concur in this; and Humboldt himself admits that clearing tends to ameliorate the temperature by removing three tendencies to cooling, viz.,—first, shelter to the soil from the sun's rays, and maintenance of greater humidity; second, evaporation from the leaves; and, third, the multiplication of surfaces, which have a cooling effect by reason of nocturnal radiations.

M. Boussingault, as we have already seen, came to opposite conclusions, since he found that where the forests are abundant the humidity that results has a cooling effect upon the climate, while dryness or aridity produce the contrary effect.

It will be found, however, that if the mean temperature remained the same, the distribution of heat through the year would change, and that thus the climate would be modified. On the other hand, we cannot appeal to documents relating to cultivation, which will not bear serious examination, as we have shown in our treatise on climates. It is possible, however, to make an advance in the study of this question, by taking into account some facts not yet mentioned.

Observations upon temperature made in the interior of trees taken in isolated places, and at the periphery of their branches, show, as we have said, that trees act like other bodies when exposed or not exposed to the solar rays; that is to say, they become warm or cool, according to their absorbing, reflecting, or conducting power, which further shows that their thermal condition depends in a great degree upon the solar action. What may we infer relative to the influence of trees upon the temperature of the air and the changes that come from clearing? These

changes come not only from the causes that we have mentioned, but also, as we need not repeat, from the nature of the soil, as whether dry, or damp, calcareous, sandy, or argillaceous. Let us analyze the effects that these may produce.

Let us first consider a wooded soil. The trees become warm, or cool, as already described; but what effect does this have if the soil is dry, or moist? If dry, there will be no effect. If moist, the evaporation of the water will produce a constant humidity, which will depend in degree upon the temperature which the trees acquire, independently of that resulting from the transpiration from the leaves. The humidity, all things else being equal, which may be caused by the trees, should be greater in a wooded country, and on an argillaceous soil, which will retain the water because the roots do not pierce it, or penetrate with difficulty into the subsoil, which, if sandy, would favor the infiltration of water. In this case, the humidity would be only such as comes from the evaporation of the leaves.

What would happen when we clear a country with an impervious, or a pervious, soil? The effects would depend on the composition of the soil, and its power of absorption, radiation, and conduction, and of these we will endeavor to present the ideas of Schubler.

We will begin by the warming of soils exposed to the sun, and shall find the following conditions in different soils:

Maximum temperature of the upper strata, the mean temperature of the air being 100.

Designation of soils.	Humid soil.	Dry soil.
	°	°
Grayish-yellow silicious sand	37.25	44.75
Grayish-white calcareous sand	37.38	44.50
Pure gypsum	36.55	43.62
Yellowish poor clay	36.75	44.12
Rich clay	37.25	44.50
White calcareous soil	36.63	43.60
Grayish-black humus	39.75	47.37
Grayish-black garden soil	37.50	45.25

We see that color and humidity are causes that exercise the greatest influence. The difference of temperature due to these causes, with that of the ambient air, in the same soil, may amount to 14 or 15 degrees.

If we pass to the property of retaining heat, we shall find that, all else being equal, the silicious and calcareous sands, as compared with equal volumes of different argillaceous or calcareous soils, in fine powder, or with humus, or with arable or garden soils, are the poorest conductors of heat. For this reason, sandy soils in summer, even during the night, preserve a high temperature; and we may conclude from this that when a sandy soil has been cleared, the local temperature should be raised, and the more so as cooling causes do not exist. After sands come successively argillaceous soils, arable and garden soils, and finally humus, which comes last. Representing calcareous sand, in its faculty for retaining heat, by 100, we have the following relative classification: sand, 95.6; argillaceous soil, 68.4; garden soil, 64.8; humus, 49.0.

We must further remember, that the faculty of retaining heat is proportioned to the size of the particles. It is from this reason that a soil covered with silicious pebbles cools more slowly than silicious sands, and that gravelly soils agree better with the ripening of grapes than chalky and clayey soils, which cool more rapidly. We see, therefore, by this, how important it is, in the examination of the thermal effects resulting from cooling, to have regard to the physical properties of the soil when once it has become denuded. This is probably the reason why Humboldt drew the conclusions deduced from thermometric observations made at stations in North America in not taking into account the nature of the soil of the denuded countries, and M. Boussingault came to different results by taking these causes into consideration.

It is therefore well proved that a soil of silicious sand and gravel, when cleared, ought to raise the mean temperature of the air more than all other soils, while at the same time it removes one cause of humidity, while if the soil is argillaceous, dry, or humid, the property of warming the air and of retaining heat, as compared with the former, is in the ratio of 68.4 to 100. The thermal effect ought, therefore, to be much less in clearing a dry ground.

We see from this in what manner we should look upon the influence of clearing upon the temperature of the air. The effects are, moreover, so complex, that we can only determine

the result by the aid of daily observations of temperature. It will also be necessary to collect maxima and minima temperatures, as these play an important part in the constitutions of climates as regards the nature of the soil. We will take up this subject again in a future memoir.

The following example is furthermore calculated to give an idea of the influences which vast forests may exert upon the climate of a country. The presence of immense forests in the tropical regions of the African continent, under the meridians of western Europe, doubtless modifies the ascending current of hot air resulting from the warming of a sandy soil, and which descends within the middle portions of Europe. If in the course of ages the sands of Sahara should become covered with wood, these sands would not become warm in the solar heat as now, and, as a consequence, the south winds which now ameliorate our climate, having no longer so high a temperature as now, would render the climate more rude. It is sufficient, to prove this, if we examine what passes on the American continent, where the tropical regions are covered by vast forests, immense savannas, or great water-courses. The descending currents of air do not warm and temper the climate of countries situated in the middle latitudes of North America so much as those of warm air coming from the Sahara, and hence the difference between countries located in the same latitudes. It is precisely for this reason that the American continent in the same latitudes is colder than ours, judging from the cultivation of the two continents, and the direction of the isothermal lines, in regions similarly exposed.

It will not suffice to study the calorific effects of clearing upon climates. We must seek to ascertain the action they exert upon springs, and the physical effects they produce in mountainous regions upon a denuded soil, as well as the effects that follow clearing upon soils of wet clay.

We will here make an observation that is not without some importance. We have seen above that a tree becomes warm, or cool, like any inoganic body, and that in proportion as the leaves become cool by night from nocturnal radiation, this loss is repaired by heat radiated from the trunk and branches. This condition of things, which has not heretofore been pointed out by physicists, hinders the air from cooling as much as if this

radiation from the trees had not taken place. The effect of woods in cooling the air is not as great as has been supposed, and the condition of the soil, moreover, modifies this influence in a singular degree.

The effects of clearing upon springs, and the amount of living waters that flow through a country, are most important points for consideration, and require serious attention. The difficulties in recognizing these effects are the greater when we are unable to say *a priori* whether a forest or a part of a forest supplies any particular spring or river.

Springs are in general due to infiltrations of rain water into a pervious soil, which it traverses until meeting an impervious stratum, over which it flows when inclined, until it comes to the surface, forming rivulets, streams, or other running waters. The water in wells has no other origin. Great springs are commonly found in the mountains. Forests contribute to their formation, both from the humidity of the soil that they produce, and the obstacles which they oppose to evaporation from the surface. Besides this, the roots of the trees, in separating the soil, render it more pervious, and thus facilitate infiltration. We cite in the memoir a certain number of characteristic examples, but will here refer to but three of the most remarkable:

Strabo informs us that it was necessary to take great precautions to prevent Babylon from being washed away by the waters. The Euphrates, he says, began to swell at the beginning of spring as soon as the snows began to melt in the mountains of Armenia, and filled the banks at the beginning of summer, necessarily forming vast masses of water, which would inundate the cultivated fields if not diverted by means of ditches and canals, and that when these canals were full, the waters spread over the plains like the Nile. This state of things no longer exists; and M. Oppert, who travelled through Babylonia some years since, relates that the mass of waters transported by the Euphrates is much less than it was ages ago, the filling of the banks no longer occurs, the canals are dry, the marshes become dry during the powerful heats of summer, and that the country has ceased to be insalubrious. This disappearance of the waters he assures us ought to be ascribed to the clearing off of forests on the mountains of Armenia.

These effects are incontestable, although there have been some persons who denied them. The examples that I am about to present furnish proofs much more forcible, because they are derived from observations that inspire confidence.

De Saussure notices the diminution of waters in the Swiss lakes as a result of clearing, especially in Lakes Morat, Neufchâtel, and Bienne. Choiseul Gouffier was unable to find now in the Troad the Scamander river, which was still navigable in the days of Pliny. Its bed is now entirely dry; and the cedars that once covered Mount Ida, where it takes its source, as did also the Simois, no longer exist.

M. Boussingault, who has studied this question during his sojourn in Bolivia, took for the subject of his observations the lakes situated in the plains or upon different stages of the mountains. The valley of Aragua, in the province of Venezuela, is a short distance from the coast, in a very favorable climate, and is very fertile. It is land-locked, the streams that flow into it having no outlet into the sea, but unite in forming Lake Tacarigua or Valenciana, which, when Humboldt saw it, at the beginning of this century, had been showing for thirty years a gradual drying up, of which they knew not the cause.

Ovideo, the historian of Venezuela, in the sixteenth century, reports that the city of New Valencia was founded in 1555, at half a league from Lake Tacarigua. This city, when seen by Humboldt in 1800, was 2,700 toises distant, showing, by many proofs, the retreat of the waters. According to this celebrated traveller, the diminution of the waters should be attributed to numerous clearings that had been made in the valley.

In 1822, Boussingault learned from the inhabitants that the waters of the lake had very considerably raised, and that lands once cultivated were now under water.

We should add, that during the period of twenty-two years, the valley had been the theatre of a bloody conflict in the war of independence. Its population was decimated, the lands remained uncultivated, and the forests, which grow with astonishing rapidity within the tropics, had reoccupied a large part of the country. We see from this the influence that forests may exert upon the waters of a country, as the lake had lost its waters by clearing, and had regained them as the country was restored in forests.

M. Boussingault cites several other examples leading to the same conclusion relative to the influence exerted by great masses of forests upon the living waters of a country. We will cite two of these that are remarkable.

In 1826 the metalliferous mountains of Marinato presented but a few miserable cabins, inhabited by negro slaves. In 1830 this state of things no longer existed. There were numerous establishments, and a population of 3,000 inhabitants. They had been obliged to cut much of the wood. The clearings had only begun two years before, yet the effects were already seen in the failing of the waters used in driving the mills. Yet a rain-gauge showed to M. Boussingault that the amount of waters falling the second year had been greater than that of the first.

The second example is taken upon the plateau of New Grenada, at an elevation of 2,000 to 3,000 meters, where the temperature of the year is from 14° to 16°(C.) The inhabitants of the village of Dubate, situated near the two lakes that were united some sixty years before, had noticed a gradual wasting of the waters, so that lands which were under water thirty years before were now cultivated, and an inquiry as to the cause led to the conclusion that the decrease had been caused by the numerous clearings of the forests that had taken place. Some lakes, such as that of Tota, a short distance from Tuguene, in localities not cleared, had suffered no diminution in their waters.

M. Desbassyres de Richemont has likewise shown that there exists on Ascension Island a fine spring of water, which was lost by clearing, and restored when the mountain was reforested.

To complete the documents proper for elucidating the question, we will add still other important observations. M. Berghaus found that the volumes of water in the Oder and the Eble had diminished between 1778 and 1835 in the former, and between 1828 and 1838 in the latter, and that this decrease still continued, and, remaining so, it was at length necessary to change the form of the boats; and statistics show that it can only be ascribed to the clearing of mountains.

Attempts have been made to ascertain whether the amount of water falling in different countries in Europe has diminished,

but without finding proofs. In fact, since 1689, it has been observed that the amount of water falling at Paris slightly increased rather than diminished. Cesaris has noticed the same at Milan, since 1763; and it is the same at Rochelle, and in the valley of the Rhone.

The hypothesis of the diminution of rains must not be rejected until we consider whether the number of rain-falls has changed, and take into account the fact generally admitted that great rains furnish more water to the rivers than the same amount of water falling through several days, with intervals of dryness between. But the discussion of observations still does not clear up the question, and we must still appeal to the changes wrought upon climate by cultivation.

It may possibly happen that earthquakes may disturb a spring by moving the strata, but this is rare. A great number of facts, on the contrary, tend to show that the diminution of volume is found almost immediately following upon great clearings. We may cite especially the example of the waters of Marmato, already noticed.

Other examples may be mentioned that are not without interest. The Romans were able to bring to Orleans the waters of the fountain of l'Etuvée, which is now entirely dry. Important excavations, undertaken some years since, have brought to light the foundations of Roman structures for supplying water where springs no longer exist; and a stream which empties into the Loire east of Orleans, and contributed in the siege of 1428, and to the turning of mills, no longer exists as it did when Orleans had great forests on that side, now cleared. By reason of this clearing the wells in the city give less water than formerly, so that the municipal authorities have been obliged in recent years to bring waters for domestic use from the sources of the Loiret, at a cost of 300,000 francs.

In the canton of Chatillon-sur-Loing (Loiret) there is a commune named Sainte Genevieve-des-Bois, which was once wooded, but now there exists only some little clumps of trees here and there. A stream flowed by the village which is now a dry channel, except when filled in winter.

In discussing the important question of the influence of clearing upon water-courses, we come to the following conclusions:

1. Great clearings diminish the quantity of living waters that flow in a country.

2. It cannot be said that this diminution is caused by a less annual rain-fall, or to a greater evaporation of rain water, or to these causes combined, or to a new distribution of the rain water.

3. Cultivation established in an open arid country dissipates a part of the currents of water.

4. In countries where no change in cultivation has occurred, the amount of living waters appears to be constantly the same.

5. Forests tend to maintain the living waters, and to regulate their flow.

6. The humidity that prevails in the woods, and the intervention of the roots in rendering the soil more permeable, must be taken into consideration.

7. The clearing of a mountainous country exercises an influence upon water-courses and springs in the plains, and especially upon the latter.

8. The action which the forests exert upon the climate is very complex.

With the means of drainage we now possess, there is no longer any fear of marshes as a consequence of clearing. We need not fear that the clearing of a country will always bring with it sterility, and will cite as examples England and Spain, of which the former has only 2 and the latter but 3.17 per cent. of wooded surface. The former has a marine climate, where the south-west winds, charged with vapor to the point of saturation, often prevail, causing fogs at the least reduction of the temperature; while Spain has a different climate, but the more fertile parts are watered by great rivers, and the great plateaux are veritable deserts.

From all this it results that if we come to clear a great forest in the vicinity of a fertile plateau with some springs, ought we not to fear that the latter will partly or wholly disappear, and impoverish the country? The clearing of a sandy country may bring drifting sands upon the neighboring plains, as it is easy to conceive from the explanation which M. Chevreul has given to the formation of dunes in the Landes of Gascony. The wind drives the sand along until it meets with some obstacle, where

it forms a mound; or the dunes obstruct the waters, which infiltrate into the sands and dampen their base. The waters by capillary attraction cause the grains of sand to adhere, and fix them in the soil. The winds take only the dry parts above, which go to form new dunes beyond the former; and so the process goes forward until it ends by finally ensanding the whole plain.

A forest, placed so as to oppose the passage of a current of damp air charged with pestilential miasms, will sometimes protect all that is behind it, while the exposed part is liable to diseases, as we see in the Pontine marshes, where the trees have the effect of taming the infected air, and purifying it of its miasms.

The forests have another effect upon climates. High trees serve as conductors of electricity, withdrawing this element from the clouds, and checking the disastrous effects of storms.

The reboisement of mountains is a first necessity for their preservation, and results in the following manner:

1. From the facility with which rain waters penetrate the soil, and even the subsoil, which the roots open to infiltration.

2. From the effects produced when the forests oppose an obstacle to masses of air saturated with vapor in motion, which does not fail to turn to rain when they are raised, crowded as they are by the obstacle.

3. From the humidity that commonly prevails in the interior, and near the woods, which leads to the precipitation of dew when the temperature is lowered.

The transformation of cleared lands into marshes is real. We will cite examples, not in Asia Minor, as has been done, but in France. When the trees are cut, the roots die, and the soil becomes compact. La Brenne, situated between the Indre and the Creuse, presents a circular area of over 200 kilometers in circumference, or about 80,000 hectares. The soil of that region is argillo-siliceous, resting upon an impervious bed of clay, of more or less thickness, which opposes the infiltration of the waters. It is covered with ponds, to which are attributed the intermittent fevers to which the population are a prey. This region was covered ten or twelve centuries ago with forests, interspersed with meadows watered with living waters, and there

then existed neither ponds nor marshy grounds, and it was renowned for its fertility, its pasturages, and the sweetness of its climate. On the clearing of these woodlands the ponds succeeded, and the lands speedily became unproductive and valueless. Their increase had come to such a point that in 1714 Bourbet-en-Brenne counted but 309.

The same thing was seen in the Sologne, which represents an area of 450,000 hectares, and of which the insalubrity is proverbial; but this deplorable condition did not always exist. Historical documents show that a great part of this country was formerly wooded. Upon clearing, followed the disappearance of the waters, wastes, and insalubrity. Now a clearing might not bring a like condition of things, since we have means, by means of drainage, of rendering fertile marshy lands that have been in this condition for many years.

In the effects produced in mountains, we are to notice the influence of roots which favor the infiltration of rain waters, and feed the springs. In such a country, clearing leads promptly to the formation of torrents, of which the Alps present numerous examples.

The effect, when the slopes covered with detritus of rocks are crowned with vegetation in vigorous growth, is, that the roots strongly interlacing form a net-work, and we see it rapidly disappear when the firs and larches on the flanks of the mountains are removed. We see that, when inconsiderate cuttings are made on these slopes, the waters flowing there carry down the vegetable soil, and a ravine is soon formed. This ravine enlarges, and becomes in time the bed of a torrent, while nothing of this is seen where the forests remain untouched. The whole eastern part of the department of the Hautes-Alps presents numerous effects of this kind.

We see, therefore, that the presence of a forest upon the soil, strongly inclined, opposes the formation of torrents, while clearing delivers the soil to this destruction. It is easy to explain the effect that follows as soon as the soil is again covered with vegetation, first of low plants, then with trees, as we have said, forming a kind of net-work that gives it consistence while the branches and leaves break the force of the storms. The trunks, shoots, and brush oppose multiplied resistances to the currents

that would otherwise erode the soil. The effect of vegetation is therefore to give greater solidity to the soil over its whole surface, and prevent it from being carried into the channel-ways, as would otherwise happen. The soil, when opened by the roots, and covered with a spongy humus, absorbs a part of the waters, that, being hindered from running off upon the surface, sink into the interior and become a supply for springs. These are the benefits resulting from the presence of forests upon mountains and inclined slopes exposed to torrential rains.

VEGETATION AIDED BY ELECTRIC LIGHT.

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On the first of March, 1881, I communicated to the Royal Society a paper on the influence of electric light upon vegetation, in which I arrived at the conclusion that the electric light was capable of producing upon plants effects really comparable to those of solar radiation, that chlorophylle was produced by it, and that bloom and fruit rich in color and aroma could be developed by its aid. My experiments also went to prove that plants do not, as a rule, require a period of rest during the twenty-four hours of the day, but make increased and vigorous progress if subjected in winter-time to solar light during the day and to electric light during the night. During the whole of last winter I continued my experiments on an enlarged scale, and it is my present purpose to give a short account of these experiments, and of some further applications of electric energy to farming operations, including the pumping of water, the sawing of timber, and chaff and root-cutting, at various distances, not exceeding half a mile from the source of power, giving useful employment during the daytime to the power-producing machinery, and thus reducing indirectly the cost of the light during night-time. The arrangement consists of a high-pressure steam-engine of six horse-power nominal, supplied by Messrs. Tangye Brothers, which gives motion to two dynamo-machines, Siemens D., connected separately by two electric lamps, each capable of emitting a light of about 4,000 candle-power. One of these lamps was placed inside a glass-house of 2,318 cubic feet capacity, and the other was suspended at a height of 12 to 14 feet over some sunk greenhouses. The waste steam of the

engine was condensed in a heater whence the greenhouses take their circulation supply of hot water, thus saving the fuel that would otherwise be required to heat the stoves. The experiments were commenced on October 23, 1880, and were continued till May 7, 1881.

THE PLAN OF OPERATION.

The general plan of operation consists in lighting the electric lights at first at 6 o'clock, and during the short days at 5 o'clock, every evening except Sunday, and continuing their action until dawn. The outside light was protected by a clear glass lantern, while the light inside the house was left naked. In the earlier experiments, one of my objects being to ascertain the relative effect of the light under those two conditions, the inside light was placed at one side over the entrance into the house, in front of a metallic reflector, to save the rays that would otherwise be lost to the plants within the house. The house was planted in the first place with peas, French beans, wheat, barley, oats, as well as with cauliflowers, strawberries, raspberries, peaches, tomatoes, vines, and a variety of flowering plants, including roses, rhododendrons, and azaleas,—all these plants being of a comparatively hardy character. The temperature in this house was maintained as nearly as possible at 60 Fahrenheit. The early effects observed were anything but satisfactory, while under the influence of the light suspended in the open air over the sunk houses the beneficial effects due to the electric light observed during the previous winter repeated themselves. The plants in the house with the naked electric light soon manifested a withered appearance. Was this result the effect of the naked light, or was it the effect of the chemical products, nitrogenous compounds, and carbolic acid which are produced in the electric arc? Proceeding on the first-named assumption, and with a view of softening the ray of the electric arc, small jets of steam were introduced into the house through tubes drawing atmospheric air with the steam, and producing the effect of clouds interposing themselves in an irregular fashion between the light and the plants. This treatment was decidedly beneficial to the plants, although care had to be taken

not to increase the amount of moisture thus introduced beyond certain limits.

EFFECT OF THE CHEMICAL PRODUCTS.

As regards the chemical products, carbonic acid, and nitrogenous compounds, it was thought that these would prove rather beneficial than otherwise in furnishing the very ingredients upon which plant-life depends; and, further, that the constant supply of pure carbonic acid resulting from the gradual combustion of the carbon electrodes might render a diminution in the supply of fresh air possible, and thus lead to economy of fuel. The plants did not, however, take kindly to these inovations in their mode of life, and it was found necessary to put a lantern of clear glass round the light for the double purpose of discharging the chemical products of the arc, and of interposing an effectual screen between the arc and the plants under its influence. The effect of interposing a mere thin sheet of clear glass between the plants and the source of the electric light was most striking. On placing such a sheet of clear glass so as to intercept the rays of the electric light from a portion only of a plant, for instance a tomato plant, it was observed that in the course of a single night the line of demarcation was most distinctly shown upon the leaves. The portion of the plant under the direct influence of the naked electric light, though at a distance from it of nine to ten feet, was distinctly shrivelled, whereas that portion under cover of the clear glass continued to show a healthy appearance; and this line of demarcation was distinctly visible in individual leaves. Not only the leaves, but the young stems of the plants, soon showed signs of destruction when exposed to the naked electric light, and these destructive influences were perceptible, though in a less marked degree, at a distance of twenty feet from the source of light. A question here presents itself that can hardly fail to excite the interest of the physiological botanist. The clear glass does not apparently intercept any of the luminous rays, which cannot therefore be the cause of the destructive action. Prof. Stokes has shown, however, in 1853, that the electric arc is particularly rich in highly refrangible invisible rays, and that these are largely absorbed in their passage through clear glass.

It therefore appears reasonable to suppose that it is those highly refrangible rays beyond the visible spectrum that work destruction on vegetable cells, thus contrasting with the luminous rays of less refrangibility, which, on the contrary, stimulate their organic action.

FURTHER EXPERIMENTS.

Being desirous of following up this inquiry a little further, I sowed a portion of ground in the experimental conservatory with mustard and other quick-growing seeds, and divided the field into equal radial portions by means of a framework excluding diffused light, but admitting light at equal distances from the electric arc. The first section was under the action of the naked light, the second was covered with a pane of clear glass, the third with yellow glass, the fourth with red glass, and the fifth with blue glass. The relative progress of the plants was noted from day to day, and the difference of effect upon the development of the plants was sufficiently striking to justify the following conclusions, viz.: Under the clear glass the largest amount of and most vigorous growth was induced; the yellow glass came next in order, but the plants, though nearly equal in size, were greatly inferior in color and thickness of stem to those under the clear glass; the red glass gives rise to lanky growth and yellowish leaf, while the blue glass produces still more lanky growth and sickly leaf. The uncovered compartment showed stunted growth, with a very dark and partly shrivelled leaf. It should be observed that the electric light was kept on from 5 P. M. till 6 A. M. every night except Sunday, during the experiment, which took place in January, 1881, but that diffused daylight was not excluded. At intervals, also, the circulation of air through the dividing framework was provided for. The results are confirmatory of those obtained by Dr. J. W. Draper in his valuable researches on plant life in the solar spectrum, in 1843, which led him to the conclusion, in opposition to the then prevailing opinion, that the yellow ray, and not the violet ray, was most efficacious in promoting the decomposition of carbonic acid in the vegetable cell. Having, in consequence of these preliminary inquiries, determined to surround the electric arc with a clear glass lantern, more satisfactory results were soon

observable. Thus, peas which had been sown at the end of October produced a harvest of ripe fruit on February 16, under the influence, with the exception of Sunday nights, of continuous light. Raspberry stalks put into the house on December 16 produced ripe fruit on March 1, and strawberries put in about the same time produced ripe fruit of excellent flavor and color on February 14. Vines which broke on December 26 produced ripe grapes of stronger flavor than usual on March 10. Wheat, barley, and oats shot up with extraordinary rapidity under the influence of continuous light, but did not arrive at maturity. Their growth having been too rapid for their strength caused them to fall to the ground after having attained the height of about twelve inches. Seed of wheat, barley, and oats, planted in the open air and grown under the influence of the external electric light, produced, however, more satisfactory results. Having been sown in rows on January 6, they germinated with difficulty on account of frost and snow on the ground, but developed rapidly when milder weather set in, and showed ripe grain by the end of June, having been aided in their growth by the electric light until the beginning of May.

REPRODUCING THE PLANTS.

Doubts have been expressed by some botanists whether plants grown and brought to maturity under the influence of continuous light would produce fruit capable of reproduction. In order to test this question, the peas gathered on February 10, from the plants which had been grown under almost continuous light action, were replanted on February 18. They vegetated in a few days, showing every appearance of healthy growth. Further evidence on the same question will be obtained by Dr. Gilbert, F. R. S., who has undertaken to experiment upon the wheat, barley, and oats grown as above stated, but still more evidence will probably be required before all doubt on the subject can be allayed.

I am aware that the great weight of the opinion of Mr. Darwin goes in favor of the views that many plants, if not all of them, require diurnal rest for their normal development, and it is with great diffidence, and without wishing to generalize, that

I feel bound to state, as the result of all my experiments, extending now over two winters, that, although periodic darkness evidently favors growth in the sense of elongating the stalks of plants, the continuous stimulus of light appears favorable for healthy development at a greatly accelerated pace through all the stages of the life of the plant, from the early leaf to the ripened fruit. The latter is superior in size, in aroma, and in color to that produced by alternating light, and the resulting seeds are not, at any rate, devoid of regerminating power. Further experiments are necessary, I am aware, before it would be safe to generalize. Nor does this question of diurnal rest in any way bear upon that of actual or winter rest, which probably most plants that are not called "annuals" require. The beneficial influence of the electric light has been very manifest upon a banana palm, which, at two periods of its existence, viz., during its early growth and at the time of the fruit development, was placed, in February and March of 1880 and 1881, under the night action of one of the electric lights set behind glass, at a distance not exceeding two yards from the plant. The result was a bunch of fruit weighing seventy-five pounds, the bananas being of unusual size, and pronounced by competent judges unsurpassed in flavor. Melons, also remarkable for size and aromatic flavor, have been produced under the influence of continuous light, in the early spring of 1880 and 1881, and I am confident that still better results may be realized when the best conditions of temperature and of proximity to the electric light have been thoroughly investigated.

THE COST OF ELECTRO-HORTICULTURE.

My object hitherto has rather been to ascertain the general conditions of this growth, from which I am led to think that the time is not far distant when the electric light will be found a valuable adjunct to the means at the disposal of the horticulturist, making him really independent of climate and season, and furnishing him with a power of producing new varieties. Before electro-horticulture can be entertained as a practical process, it would be necessary, however, to prove its cost, and my experiments of last winter have in part been directed towards that object. Where water-power is available, the electric light can be

produced at an extremely moderate cost, comprising carbon electrodes, wear and tear of and interest upon apparatus and machinery employed, which experience elsewhere has already shown to amount to 6d. per hour for a light of 5,000 candles. The personal current attention requisite consists simply in replacing the carbon electrodes every six or eight hours, which can be done without appreciable expense by the under-gardener in charge of the fires in the greenhouse. In my case no natural source of power was available, and a steam-engine had to be resorted to. The engine of six nominal horse-power which I employ to work the two electric lights of 5,000 candle-power each, consumes fifty-six pounds of coal per hour (the engine being of the ordinary high-pressure type), which, taken at 20s. a ton, would amount to 6d. per hour, or to 3d. per light of 5,000 candles. But against this expenditure has to be placed the saving of the fuel effected in suppressing the stoves for heating the greenhouses, the amount of which I have not been able to ascertain accurately, but it may safely be taken at two thirds of the cost of the coal for the engine, thus reducing the cost of fuel per light to 1d. per hour. This calculation would hold good if the electric light and engine power were required during say twelve hours per diem, but inasmuch as the light is not required during the daytime, and the firing of the boiler has nevertheless to be kept up in order to supply heat to the greenhouses, it appears that during the day-time an amount of motive power is lost equal to that employed during the night.

WORK FOR THE DAY-TIME.

In order to utilize this power, I have devised means of working the dynamo-machine also during the day-time, and of transmitting the electric energy thus produced by means of wires to different points on the farm, where such operations as chaff-cutting, timber-sawing, and water-pumping have to be performed. These objects are accomplished by means of small dynamo-machines placed at the points where power is required for these various purposes, and which are in metallic connection with the current-generating dynamo-machines near the engine. The connecting wires employed consist each of a naked strand of copper wire supported on wooden poles, or on trees without the use

of insulators, while the return circuit is effected through the park railing or wire fencing of the place, which is connected with both the transmitting and working machines by means of short pieces of connecting wires. In order to insure the metallic continuity of the wire fencing, care has to be taken, wherever there are gates, to solder a piece of wire, buried below the gates, to the wire fencing on either side. As regards pumping the water, a three-horse-power steam-engine was originally used, working two force-pumps of 3½ inches diameter, making thirty-six double strokes per minute. The same pumps are still employed, being now worked by a dynamo-machine weighing four hundred weight. When the cisterns at the house, the garden, and the farm require filling, the pumps are started by simply turning the commutator at the engine station, and in like manner the mechanical operations of the farm, already referred to, are accomplished by one and the same prime mover. It would be difficult, in this instance, to state accurately the percentage of power actually received at the distant station, but in trying the same machines under similar circumstances of resistance, with the aid of dynamometers, as much as 60 per cent. has been realized.

WHAT MAY BE DONE.

In conclusion, I have pleasure to state that the working of the electric light and the transmission of power for the various operations just named are entirely under the charge of my head gardener, Mr. Buchanan, assisted by the ordinary staff of under-gardeners and field-laborers, who probably never before heard of the power of electricity. Electric transmission of power may eventually be applied to threshing, reaping, and plowing. These objects are at the present time accomplished, to a large extent, by means of portable steam-engines—a class of engine which has attained a high degree of perfection. But the electric motor presents the great advantage of lightness, its weight per horse-power being only two hundred weight, while the weight of a portable engine with its boiler filled with water may be taken at fifteen hundred weight per horse-power. Moreover, the portable steam-engine requires a continuous supply of water and fuel, and involves skilled labor in the field, while the electric engine receives its food through the wire (or the light rail upon

which it may be made to move about) from the central station, where power can be produced at a cheaper rate of expenditure for fuel and labor than in the field. The use of secondary batteries may be resorted to with advantage to store electrical energy where it cannot be utilized. In thus accomplishing the work of a farm from a central power station, considerable saving of plant and labor may be effected. The engine power will be chiefly required for day work, and its night work for the purposes of electro-horticulture will be a secondary utilization of the establishment involving little extra expense. At the same time the means are provided of lighting the hall and shrubberies in the most perfect manner, and of producing effects in landscape gardening that are strikingly beautiful.

THE FARMER'S FOOD.

BY C. C. LORD, HOPKINTON.

Farmers are sometimes said to form the substratum of society, because they raise the food of the community. No one will dispute the logical value of this claim. In the present instance we wish to entertain the general proposition with reference to the theory of a mutual relation between means and end. It is asserted as a true rational principle, that the end is always equal to the cause that produces it. Producing the material sustenance of the community, the farmers themselves should be well sustained in order that there may be the most adequate expression of social cause and effect. The intelligence of the farming population should therefore be directly concerned for its own perfect sustenance, both for its own good and the good of society. We propose to treat briefly the subject of the sustenance of the farming population: but, because the present conditions of expression are of course limited, we propose to speak of sustenance in a strictly technical sense, or as meaning simply the support of the stomach. Further, and for the reason already mentioned, we shall mainly or wholly adapt our observations to our own geographical location, or New Hampshire.

For greater convenience and exactness of details, we shall consider the subject of the farmer's food under various subdivisions, as follows:

1. The supply of food.
2. The consumption of food.
3. The dynamic economy of food.
4. The hygienic property of food.
5. The æsthetic relation of food.
6. The moral importance of food.

Considering these subdivisions in the numerical order indicated, we proceed.

1. *The supply of food.* In the discussion of this point of our subject, we admit an inference directly natural to one contemplating the general situation. The practical farmer being a food producer, a source of sustenance to the community, must naturally produce more food than he himself needs; consequently his profits, as a successful and prosperous member of society, must measurably accrue from that harvest of food which he gathers over and above the requirements of his own household. However, we do not wish to decide this point by mere inference, but propose to make a reasonable calculation of the probable food resources of an average New Hampshire farmer.

In speaking in this connection of a reasonable calculation, we do not necessarily mean an exact one. In the manifest nature of the case, our conclusions must be approximative, owing to the probably imperfect character of the data within our reach. This condition largely obtains in the instance of all calculations of the kind we are undertaking.

In the year 1880, according to the census then taken, New Hampshire returned a small fraction less than eight bushels of corn and grain for every inhabitant of the territory. When we consider that a large number of New Hampshire people are non-producers of food, being engaged in other than agricultural pursuits, we must conclude that the farmers of New Hampshire must have raised more than eight bushels of bread-stuffs for every man, woman, and child that represents our agricultural population. Now when we consider that our merchants, as we are told, estimate a barrel of flour, which represents five bushels of wheat, to be the equivalent of all the bread-stuff needed by an average individual for a year, we must conclude that the approximate seventeen or more bushels of corn and grain raised for every individual of the farming population of New Hampshire, as indicated by further calculation, must be bread-stuff enough, if it is not in truth far more than enough. Yet it is estimated that New Hampshire pays annually $3,675,000 for flour of wheat. Then what becomes of the eight bushels of corn and grain per head of the entire population, and seventeen per head of the farming population, that are annually raised in

our state? But this is the question we wish to induce our readers to reflect upon in the light of at least six points of this article.

However, physically as well as morally speaking, we have to consider that man doesn't live by bread alone, and hence look for other means of sustenance for New Hampshire farmers than corn and grain. We submit, therefore, that an approximate calculation from our last census returns shows that in addition to seventeen or more bushels of bread-stuffs, every person probably belonging to our state agricultural population has the potential profit of more than one neat stock, more than one sheep, about one third of a hog, besides more than twenty bushels of potatoes, and more than six dollars' worth of orchard products, not to mention any resources from the poultry yard or from miscellaneous field and garden produce. It is now proper to ask our readers to reflect whether or not, and to what extent, our New Hampshire farming population can actually live upon the soil. To aid in this reflection we invite attention to another point.

2. *The consumption of food.* In the consideration of this point, we propose to indulge reflections upon the way to consume food, or how to eat. In this connection, also, we desire to say that we intend to advocate no theory or hobby other than that which nature seems to indicate. In saying this, we do not mean to imply that nature in mere spontaneity of expression is adequate to fulfil all the dietary wants of rational man; but we do think that nature, in its crude manifestion, points out the paths we must follow, if we are to realize the higher privileges of living. Not to consume time and space in illustrating the details of our conceptions of this matter, we pass on to say that it is our belief that the natural and consistent dietary wants of man are multiple, and that he needs all those elements of nature that produce not only bone, sinew, muscle, nerve, fat, heat, and strength, but are combined in those natural proportions and relations most favorable to their successful appropriation, assimilation, and incorporation as integral elements of the human body. In a word, the study of nature's methods teaches us that food elements that are mechanically or chemically concentrated are neither suitable nor safe when used as main reli-

ances of diet. We hold that it is in the lack of consideration of the proposition we here advance that the farming population of New Hampshire in general errs, and errs greatly. The farmers of our state eat too much concentrated food. This fact is true of their bread perhaps more than of anything else, and, though we do not live by bread alone, yet bread is such an important factor in our dietetic resource that it is actually, as well as poetically, the staff of physical life. Here our reflections tend to another subdivision of our theme.

3. *The dynamic economy of food.* The farmers of New Hampshire are a laboriously practical class of human beings. The nature of their industrial and climatic necessities implies this. In order to labor hard in a climate that affords over half a year of comparative cold, one needs a liberal supply of heat-producing elements in his food. A New Hampshire farmer cannot exist upon a diet that simply supplies the waste of tissue incident upon the bare functional activity of the human system in luxurious ease and independence; he must eat not only to live, but to be able to resist the debilitating force of the climate, and to surmount the thousand and one obstacles that stand in the way of his domestic prosperity. Our local farmer must physically engender an abundance of heat to be expended in counteracting cold, and by the transmutation of energy in developing strength for work. Now there are two sources from which he may draw this extra potential energetic supply. He has both the animal and vegetable kingdoms as a source of reliance, but he persists in drawing the greater part of it from the vegetable. Carbonaceous aliment in a highly concentrated form can be obtained from animal resources, but the more refined instincts of human nature revolt at the idea of generally appropriating simple carbonaceous food from such a source. Civilized people generally revolt at the thought of eating pure and simple lard, tallow, fat, etc.; hence, with the exception of butter of milk, they largely refuse to partake of these things to any great extent except in culinary combinations. It remains for the vegetable kingdom to furnish the larger part of the food consumed as comparatively pure carbon—in the fine flour of wheat—in the consumption of which the greatest variety of preparative formulas are indulged.

Now if carbon were the only useful dietetic element contained in wheat, or if wheat were the only cereal product containing a bounteous supply of carbon in combination, there were more dynamic economical consistency in the general practice we have described. However, the truth is, wheat contains numerous other valuable nutritive elements besides carbon; and corn, rye, barley, oats, etc., though not so easily floured as wheat, contain such an abundance of carbon in combination with other useful elements that they properly come into economic competition with wheat as reliances for human sustenance in the form of bread. In fact, in the wide range of cereal products, we have both flesh-producing and heat-producing food-elements in abundance, and admirably adapted to reception by the human stomach. Here, also, we trend upon a consideration of the dynamic economy of food that is of most signal importance, because it involves the dynamics of money. In rejecting, as main reliances for bread, all the cereals except wheat, which they appropriate only as flour, our farmers throw away corn, rye, barley, buckwheat, and oats, and one third of their wheat (the estimated ponderable loss in bran and middlings), at a price ranging from fifty cents to two dollars per bushel; but, as they must in the nature of the case derive flesh-producing elements of food from some source, they make the animal kingdom a principal source of supply, taking back that they have just thrown away so cheaply, receiving it again at a price ranging from six dollars to twelve dollars per hundred pounds, as in pork and beef, for instance. We therefore submit, that if the farmers of New Hampshire were to rely mainly upon the whole range of unbolten cereals for their bread, which they can do with reasonable facility, they would need and desire less meat, while the pecuniary advantage would be of a most marked and unmistakable character.

4. *The hygienic property of food.* Both reason and experience teach man that a consistent habit of diet regards the health of the physical frame. The physical man, also being complex in structure, and hence compound in functional manifestations, both theoretical and practical judgment indicate multiple resources of food. Man cannot live by bread alone, and the indications of present society scarcely imply that he can

in general restrict himself wholly to either the animal or the vegetable kingdom as an alimentary reliance. Yet, as we have already considered, in New Hampshire, among tillers of the soil, bread is a most important ingredient of diet, and it therefore becomes proper to inquire concerning the most healthful method of supplying the system with it. To make our ideas more clear, we propose to present our argument in this case upon the plane of analogy. In this we imply the essential unity of all physical forces. Heat is everywhere the product of combustion. To produce heat and power, either in a locomotive or a human body, we burn fuel. Now it is unnecessary, in the presence of a person of fair scientific judgment, to state that, other things equal, a concentrated form of fuel will produce the most motor energy. But in the case of the human body, the conditions are not equal. A quantity of hard coal, introduced into a locomotive, will develop more power than an equal quantity of wood; but the coal incurs by use an extra tax upon the material of the engine. Hence, in burning coal, the locomotive requires an extra lining in the fire-box. By analogy, therefore, we must expect that the habitual consumption of concentrated food by the human system will incur an extra strain upon the frame itself, and there appears to be no adequate available resort analogous to the operation of putting an extra lining in the fire-box of the locomotive. Such resorts as people are in the habit of adopting in the economic effort to counteract the direct effects of using too much concentrated food are largely factitious in character, partaking of the nature of artificial promotors of action, that force and still further exhaust the reserve energy of the system. The practice of eating highly concentrated food tends to shorten life—a result that the cultivated intelligence of society regards with regret, since consistent philosophic thought considers the advantages of life, notwithstanding its toils and perils, to be so great that the needless abridgment of it is reprehensible.

We have thus compassed this part of our theme, as it were, in a nutshell. If we had space at command, we could enter into numerous illustrations of the scientific force of the position we take. However, certain other incidental reflections occur in the consideration of subsequent points.

5. *The æsthetic relation of food.* We hardly think it possible that a person of fair individual capacity and judgment can have given practical predominance to the dietetic regimen we have briefly pointed out, and done so for a reasonable length of time, and not have realized a superior æsthetic tendency in his nature. In general society, this tendency is expressed in at least three ways,—in the elevation of the instincts, in the superior equilibrium of the mental powers, and in the increased facilities for special improvement. We have already incidentally touched upon the first phase of dietetic æstheticism, when considering the dynamic economy of food, asserting that the instincts of our nature incline rather to concentrated vegetable aliment than to animal. This is an aspect of our subject that appeals to the minds of reflective persons oftener than many readers are aware. In our own case, we have been repeatedly called upon to notice the doubtful apprehensions with which persons of refined intelligence contemplate an unusual disposition to incline to an animal diet. Upon this phase of dietetic science the best mind of civilization has been occupied to a greater or less extent in all ages. We do not think the most accomplished mind in society to-day will contradict us when we say, that any practical barrier to the too generous appropriation of animal food by the masses of any community ought to be hailed with joy. Not to speak fanatically, there is at least a measure of practical value in the theory that we approximate in a degree to the analogical constitution of that which we eat;—hence, by receiving a considerable portion of our flesh-making as well as of our heat-producing food-elements from the highest orders of the vegetable kingdom, as we do in cereal products, we are benefited, through the operation of a subtle law of nature that is more easily understood than explained. In regard to the second phase of this æsthetic bearing of our subject, we have little more to say than by the maintenance of a better condition of physical health, by avoiding so far as possible all undue taxing and racking of the constitutional energies, we secure a greater freedom of the mind and the privilege of a higher endowment of all its attributes. A worn and wearied body is the habitation of a worn and wearied spirit, and too much wear and weariness are incompatible with æsthetic culture. In respect to

the third phase of æsthetic causality, we claim, as a matter of direct inference, that by shortening the distance to any goal we save both time and strength. In taking more than they now do of their food from the cereals, in the manner we have described, the farmers of New Hampshire will save many a stroke of toil. They (or what is the same, their families) will save that extra manipulation of food-supplies that comes by the longer road to the butcher's and the grocery-man's, both through living more upon their own direct resources, and avoiding that factitious demand coming from excessive desires created by injudicious dieting, which latter consideration invites us to our last specific point in this subject.

6. *The moral importance of food.* The consideration of this point involves more than the assumption that starvation is the mother of crime. Our readers will understand this by reverting to our previous calculation of the approximate quantity of food raised for every individual of the farming population of our state. Our present is a more subtle yet equally true conception of the relation between dietetics and morality.

We apprehend that there is no true morality that is not directly related to the consistent control of human passions or appetites. Whoever gives free rein to his appetites is immoral, and he that is incapable of control over his desires is immoral, though he may not be culpable. In this view of the subject, unrestrained gluttony is immoral, though the gormandizing may result from an abnormal condition not within the knowledge of him who is the subject of it. In the progress of this article, we have spoken of an abnormal dietetic result incident upon the over-taxing of the constitutional energies of the system by the consumption of too concentrated food in the form of bread. We apprehend, further, that this conception of our theme is closely related to the true theory of drunkenness and kindred evils. Passing the general fact that it is rarely that an habitual drunkard is to be found who is not also a glutton, we take up certain operations of physiological law that play between the adoption of a false diet and the expression of an abnormal moral condition. We have affirmed a necessity to exist in New Hampshire in respect to the diet of the farmer, he being a laborer, the necessity implying a considerable consumption of heat-produc-

ing food. Now, it is an inevitable law that every effect requires an adequate means. When a man eats liberally of food rich in nutritive elements, the circulating forces of the body are energetically directed inwardly; for the promotion of digestive and assimilative results. This operation implies an existence of an extra degree of animal heat in the mucous surfaces of the alimentary canal, which, in the instance of the presence of a large quantity of nutritious food, may incur injury, unless counteracting effects are produced by the instincts or judgment of the person. Hence, all persons experiencing the case described will drink more or less water, while an individual of greater cerebral and nervous temperament will incline, in the general variation of food, to a liberal use of succulent fruits, and a person of a more abdominal, obese, and phlegmatic habit will exhibit a similar preference for watery vegetables. Both fruits and vegetables supply nutrition, but they measurably serve as refrigerators, as may be naturally inferred from their bounteous supply in summer, when they are needed most. But let us suppose that a person, industrially exposed to the climate of New Hampshire the year round, persists in taking heat-producing elements of food in a concentrated form: in this case there is an inevitable tendency to resort to correspondingly concentrated refrigerators of internal heat. Some people, in such a case, rely more or less upon stimulants, because they temporarily revive the general circulation, driving the internally accumulated blood back toward the surface of the body; others incline to concentrated acidulous or sour substances as internal coolers, as when they become so addicted to acids that vinegar and pickles seem at times to be almost the chief reliances of their stomachs. Now we assert our belief, that, other things being equal, a man who habitually avoids chemically and mechanically concentrated forms of nutriment in his food will not be likely to incur excesses in the use of any of those occasional accessories of diet that are specially implied in undue indulgence of the palate.

In attempting to conceive of the highest privilege of humanity, we cannot exclude the idea of personal self-government. To be able to live, move, and have our being without subjection to domination from some factor of our nature that instinct teaches us is by right only an accessory and not the principal power, is

a privilege that no consistent mind will underrate. To be in slavery to an animal appetite is deplorable bondage; but, when we admit an abstract moral consideration, we cannot see how there is more essential immorality in bondage to an appetite for alcohol than there is in slavery to a desire for pickles, or any other factitious accessory of diet. In the social relation the aspect may be different; in the individual the rational condition is the same.

Having thus briefly elucidated the six subordinate points of this article, we are sensible that the space we have already taken warns us to close. We find ourselves subject to disappointment here, because we have, after all, said so little upon a theme that is so prolific in ideas. We really expected to say more when we began, but in progress have felt obliged to omit many thoughts and illustrations lest we unduly extended our observations. We now give brief attention to a closing reflection. Assuming that some readers may be willing to inquire the reason of our presentation of this article, we will say, We have not written this because we think that every New Hampshire farmer should subsist exclusively upon his farm; neither because we consider that in any probable case one should never in any instance partake of a morsel of concentrated food; nor because we believe that if the theory of dietetics we advocate were generally practised all the moral obliquities of society would suddenly disappear. We have written this because we sincerely believe we thus point out one of the many agencies adapted to the improvement of our common humanity,—in fact, so important an agency that no person who aspires to a representative intellectual position in the social world should any longer overlook it. Speaking through an agricultural medium, we have addressed our thoughts to the community of New Hampshire farmers. Now, to revert to an earlier position taken in this article, we reassert the importance of the functional relation of the farming community as a factor in the general social fabric. In order to fulfil his duty to the world in the best manner, the representative farmer should attain the highest possible standard of manhood —physical, as well as mental and moral; in fact, physical, mental, and moral attributes should combine in one composite structure of improved human nature. Further, as we also said

at the beginning, the end is always equal to the cause that produces it. With adequate resources, men may become successful farmers, and successful farmers eminently advance the interests of society at large. In our approximate computation of domestic dietetic resources of our New Hampshire farmers, we have conclusively shown the abundance of the facilities for adopting a system of general feeding that will not only profitably conserve the physical, mental, and moral energies of our agricultural community, but incidentally the pecuniary as well. We contend that economy, like charity, begins properly at home; and there appears to be no serious drawback to success in the application of the theory that the farmers of New Hampshire, as a whole, have the means of adopting a dietetic resource essentially promotive of their general welfare and of the advance of related public interests.

THE ANCIENT MERRIMACK AND ITS GLACIERS IN APHELION WINTER.

BY S. D. LORD, ESQ., OF MANCHESTER.

Looking at the Merrimack river, we see its waters flow in a comparatively small channel, but at the same time the form of its banks and its several receding terraces, now level, now inclining, extending sometimes a mile on either side, satisfy us that at some time in its geological history its waters were made to flow over a greater space, under very different conditions from the present.

We have seen the current voraciously take away sand and soil from one side of the stream, and at the same time gently deposit the like on the other side, and we have seen river beds filled, the strata of sand and mud deposited one above the other, until after a few years they rise above the level of the stream and become permanent dry land, and vegetation grows thereon. The character of such formations is not unlike that of the river banks and terraces along the Merrimack, from its rise to the ocean. That these banks and terraces are the work of water, no one for a moment can question. But when we speak simply of the action of water in producing these formations, we are not satisfied to stop here, for our belief goes further, and we seek to know the causes of these phenomena.

In riding from Hooksett to Suncook, near the mills, southwesterly from the great clay banks, we may see a boulder of great proportions, weighing some hundred tons, bedded in the sand and clay of that place. It is a gneissic rock, and the sand and clay there could, under no ordinary transformation, form such a rock. It is in composition foreign to the place. Further north, near the railroad track, excavated from the sand, we see

many other smaller boulders, of granitic formation. But such boulders are found everywhere in New Hampshire.

Whence came these boulders? Differing in composition from the surrounding sand or earth, we know they are not natives of the place: they are foreign to it, and were transported there by some force that has now ceased to exist.

The Secretary of the Board of Agriculture, in boring a well on his farm on the Merrimack river, beneath a few feet of interval soil came to clay, which he found to be some forty feet thick, and below this clay, at a depth of eighty-two feet, through successive layers of sand, clay, marl, and gravel (all being a sedimentary deposit), he reached a pebbly formation, the undoubted bed of the ancient river.

Now, the action of water under varied circumstances might produce these formations of the banks, terraces, and sedimentary deposits of clay and sand; but its action in this way does not account for the boulders we find. They do not swim in the water, but they are and can be transported on the ice, which may float in water: and here we come boldly to the suggestion of the floating ice, or more tardy glacier, in the valleys of the Merrimack and its tributaries.

At the first thought this suggestion may seem incredible, but we read of and see the glaciers in the Alps, and even nearer to us, in Greenland, and we know of their existence at the present time in nearly every lofty mountain; and when we see the marks, striæ, and scratches upon the highest rocks, and boulders scattered everywhere, which mark the tracks of the glacier or floating ice, and which the geologists follow with as much certainty as the hunter does the tracks of the deer, we are convinced there is no other true interpretation; and yet it is only a few years that we have dared to entertain such a thought.

Geologists have traced the river Rhone from its beginning, in the glacier at the foot of the Alps, to the Mediterranean. On this river is the celebrated Lake Geneva, fifty miles long and from two to eight miles wide; and we are told that this lake was scooped out by the glacier that once moved down that valley. Looking to the Switzerland of America, it is not incredible that our own Winnipiseogee was formed by the same force of the glacier, for the evidence is just as strong.

The Massabesic is surrounded by hills: the outlet is over a hard ledge, now worn down by the water and ice to its present level, that in glacial times was many feet higher. These reservoirs of the Winnipiseogee and Massabesic are the work of erosion,—once plains, and by the erosive force of water and ice dug out, and the mud and sand washed down the valley of the Merrimack, forming in part its banks and terraces of to-day. Such instances are common in all parts of the state, where the same forces have done like work, and left the evidences behind them in the form of lakes and ponds of all sizes.

The Yosemite valley was once filled with the glacier and floating ice; the great cañons of the Colorado were caused by the erosions of water in glacial times; and why have we not the indisputable right to say the cañon of the Merrimack shall be interpreted in the same way?

But, you will say, before we can have the ice and snow of the glacier we must have the temperature fit to produce it; and if this condition is established, no one can doubt.

Thousands of years ago, all admit there was an age of ice, and many men of science believe these glacial periods have occurred in all the different geological divisions, at times of high eccentricity. Mr. Croll, one of the best authorities on this subject, says that the glacial age must have occurred between 720,000 and 980,000 years ago, or between 80,000 and 240,000 years ago; and he further says, "on this point I consulted several eminent geologists, and they all agreed in referring the glacial epoch to the former period, the reason assigned being that they considered the latter period much too recent and of too short duration to represent that epoch." He however refers it to the latter. He might have referred to both, and others previous also. I do not propose to invite you in this paper to go back so far as those ages, but only some 12,000 years, where I hope to be able to find conditions fit for a New Hampshire glacier, and this by simple astronomical facts which we learn in our schools, that, if applied to our subject, must be apparent to all.

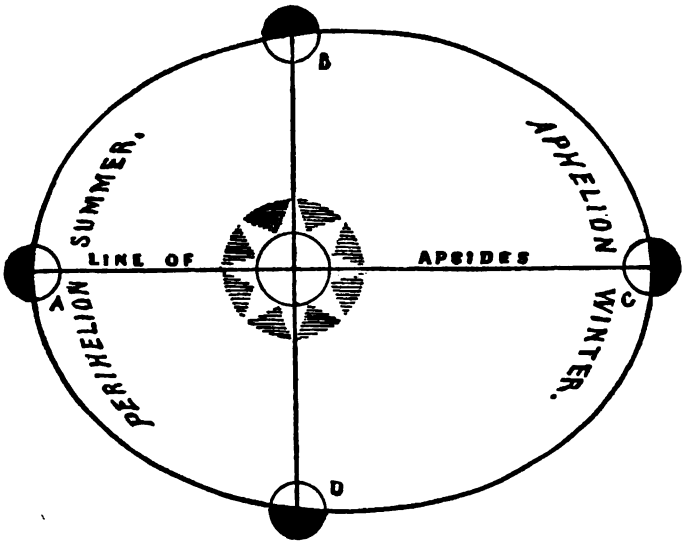
To begin, let me refer to some meteorological conditions and data which you may all know. The mean annual temperature of Concord is about 45°; north it will be lower, and south higher. I assume that the mean annual temperature of the state

is now 45°. Since the freezing point is 32°, we have only to find a temperature averaging 13° below the present to represent one proper for snow and ice, in some parts at least, the year round. Snow now remains during nearly the whole year in some parts of the White Mountains, and it was particularly noticed in the summer of 1882, in some of the ravines there, very late. On the first of July, 1883, the snow in Tuckerman's ravine, in places, was fifty feet deep, and did not disappear till the first of August, and again appeared the 9th of September. But how shall we account for so low a temperature as we seek, necessary to produce a glacier? Is not the heat of the sun the same from year to year, equal in intensity? Did New Hampshire ever have a temperature in which snow remained for the whole year, and year after year accumulating, until it reached an altitude higher than Mt. Washington? How otherwise will you account for those scratches on the summit rocks, their channelling, the striæ, all parallel, pointing in one common direction, unless the glacier or ice sheet reached even higher, and in its movement, with rocks frozen in it, chiselled out the channels and grooves we find on the lofty mountain ledges and rocks? Prof. Dana claims that in northern New England the ice had a mean thickness of 6,500 feet, while between the St. Lawrence and Hudson's Bay it was not less than 12,000 feet.

There are three causes (astronomical) that I give as sufficient to produce such a climate: 1, the *precession* of the equinoxes; 2, the *obliquity* of the ecliptic; 3, the *eccentricity* of the ecliptic: and it will be observed that these all relate to the ecliptic—the orbit of the earth in its annual motion around the sun.

I will now discuss the *first, the precession of the equinoxes.* By "equinox" is meant "equal night," and there are two points on the line of the earth's annual motion where there are equal days and equal nights. They are those points where the sun, as we say in common language, "crosses the line." Now the exact point where the "sun crossed the line" in March, 1882, was not the point where he "crossed the line" in March, 1883. The difference between these two points is 50.44″, according to Stockwell, as given by him in the 18th vol. Smithsonian Contributions, &c. The point of crossing varies this amount annually to the west. By reducing the whole ecliptic of 360° to seconds,

and dividing by 50.44″, we find the quotient nearly 25,694 years as the time required for completing the whole ecliptic, or the precession period. But while the equinoxes move to the west towards perihelion, the perihelion also moves towards the equinoctial about 12″ annually, so these two points are approaching each other by the sum of 50.44″ and 12″, or about 62½″ annually;—and now again reducing the 360° of the ecliptic to seconds, and dividing by 62½, we find the period is reduced from the 25,694 to about 21,000 years. This will be better understood by studying the diagram, which represents the positions of the earth and sun with reference to the ecliptic 12,000 years ago. But we must remember the positions at the present time are the reverse of those of 12,000 years ago, our present winter being in perihelion with the earth at A, moving in winter from B through A to D, and describing the arc D, C, B in summer.



The ecliptic, it will be seen, is represented an ellipse in form, the earth moving round the sun in the direction of A, D, C, B. We will consider the line of Apsides, A, C, as coincident with the equator.

Taking A as a starting-point, the earth will move on the ecliptic through D, C, B, and reach A, or rather a new equinoctial

point 50.44″ west from A, towards B, in a year, and this equinoctial point at A will move annually this distance of 50.44″ towards B. This movement is called *precession*, because the point where the earth reaches the equinox *precedes* the previous year by this distance, and in time this point will recede to B, then to C. But again, the line of Apsides moves in a contrary direction, C towards B, 12″ annually, and we have seen that in about 10,500 or one half of 21,000 years, they will meet somewhere between C and B, moving over half of the ecliptic, the whole being some 21,000 years.

The line of Apsides, A, C, measures the distance between aphelion and perihelion;—being opposite each other, the movement of these points is consequent, of course, upon the movement of the ecliptic itself. This change of perihelion in reference to the motion of the earth is considered in the astronomical relations of the earth to the fixed stars, and the revolution of the earth from perihelion round to perihelion again is called the *anomalistic* year, four minutes longer than the equinoctial year. Looking forward, we find the earth in this movement, in the year 11,928, will be in aphelion in winter again, and most distant from the sun.

The seasons change with the change of the equinoxes. One fourth revolution gives winter for spring, and one half revolution gives winter for summer, and this is the change from perihelion to aphelion. This change of seasons from the perihelion to aphelion it is important to remember in reading this paper, since it is by reason of the transfer of the perihelion winter to aphelion winter that the climate we seek is to be found. The present winter in perihelion was 10,500 years ago in aphelion; the earth was, therefore, 3,000,000 of miles farther from the sun than at present, one thirtieth of the whole distance of the earth from the sun, and consequently colder.

In 1250, or 634 years ago, the solstice and perihelion were at the same point on the ecliptic, we are told by astronomers, and if we take that as the starting-point, 634 years of the present perihelion winter have passed, which, added to 10,500, gives us the date of the beginning of the last aphelion winter as about 12,000 years ago, hence we conclude we are approaching a colder period.

Summer is now eight days longer than winter, because in aphelion, so the aphelion winter is eight days longer than the perihelion summer; and taking the eight days from the perihelion summer and adding eight days to the aphelion winter makes a relative difference of sixteen days for the aphelion winter over the present.

We may, then, have some conception of such a winter. But the summer coming in perihelion must have been so much the warmer, and one would say warm enough to compensate for the cold of winter. This is true in theory; but a meteorological principle comes in here, viz., that the extra heat is cancelled or absorbed in converting the snow and ice of the previous winter to water, and in other ways; for the greater the extremes of heat and cold the greater and denser the clouds will be, the greater the heat applied to the boiler the greater will be the quantity of steam, and the summer of 12,000 years ago might for this reason, through the density of the clouds and the loss of heat in the great evaporation, be even colder than the present. Let us see an application of this in our present temperature. The sun, for a month before the September equinox and a month after the March equinox, is in the same relative position to the equator, and to us at the same angle and the same distance, and the same amount of heat is distributed over our zone; yet there was a mean difference of 21.64° in temperature in those times in 1883.

Mr. Meech, a writer on *Light and Heat*, referring to this subject, in high latitudes, says,—"According to Dr. Kane and others, a dense and lasting fog prevails after the middle through the rest of the summer season, and effectually prevents the rise of temperature, which the sun's intensity would otherwise produce." This is to be explained in the loss of heat in the work of evaporation, and reducing the snow and ice to water, producing fogs and clouds which intervene between the sun and the earth. This much for precession. I shall recur to this again, and be more particular as to the range of the thermometer in the aphelion winter we have found.

Some fifty years ago Adhemar, a French mathematician, recognizing the effect of the precession period on the climate, contended that periods of heat and cold followed each other every

10,000 years,—consequently ice and cataclysms succeeded each other accordingly; that the vast aggregations of ice at the North pole in aphelion winters, and its melting and floods in the approach of the perihelion winter, account for geological cataclysms of the past. It is not, however, advocated at present.

The second reason for a reduction of temperature 12,000 years ago was in consequence of the greater obliquity of the ecliptic at that period. By the obliquity of the ecliptic, astronomers mean the greater angle it forms with the equator; in other words, the further south the "sun goes," the greater obliquity of the ecliptic.

The sun in winter, at the solstitial point, is 23° 27½′ south of the equator, and this obliquity causes our winter, because the less vertical his rays are to the earth the less heat we have from the sun; and we are told by astronomers that the sun may go to a solstitial point 24½° south, or one degree more than now, and at about that period it did go south to that degree; and Stockwell finds that 8,000 years ago it did go to the southern solstitial point of 24¼°. The obliquity changes about 46 seconds of a degree per century.

On the basis of these figures, it was colder by this one degree of latitude of the sun further south by several degrees of the thermometer in northern latitudes. The sun, in his annual journey south, is four days in passing one degree of this obliquity, and he is also as many days returning, which adds eight days more to the aphelion winter of that period; and the same time being taken from the summer gives a relative difference of sixteen days more for that winter than at present. This difference must be allowed simply to the obliquity of the ecliptic at that time. We have, then, found thirty-two days more for the aphelion winter past than for the present winter.

I have said the earth was 3,000,000 of miles nearer the sun at perihelion than at aphelion. Now, at that period, 12,000 years ago, the distance was more than 3,000,000 by one half million nearly, according to Leverrier. We see, then, it was colder in consequence. This difference of one half million of miles in the eccentricity of the ecliptic is the third reason I have named for a cold period at that time.

This shrinkage of eccentricity, now amounting to one half

million of miles since the aphelion winter, will continue till the earth's orbit will become nearly a circle, never, however, to reach a circle before the eccentricity will increase again, and so continue and produce in the distant future perhaps another ice period like those of 80,000 and 240,000 years ago. Two hundred thousand years ago the eccentricity was 10,500,000 miles, and 850,000 years ago it was 13,500,000, according to Leverrier, now only 3,000,000; and these are the periods to which Mr. Croll refers as the great glacial epochs I have named. Probably no man has ever given this subject more attention than Mr. Croll, and, as his conclusions are pertinent and in the direction of my argument, I will quote from him. "About 11,700 years ago," he says, "the northern winter solstice was in the aphelion. The eccentricity at that time was .0187, being somewhat greater than it is now, but the winters occurring in aphelion instead as now in perihelion, they would on that account be probably 10° or 15° colder than they are at the present day." But this was spoken of the English climate, modified then as now by the Gulf stream; and if we apply the doctrine of inverse squares, the reduction of temperature would be 20°, for the influence of the Gulf stream does not reach us, and New Hampshire had nothing to temper the severity of an aphelion winter.

Let us review. We have seen that, through the precession of the equinoxes, the northern hemisphere was in aphelion 12,000 years ago in winter, and, consequently, 3,000,000 of miles further from the sun than in our present winter; that the aphelion winter is eight days longer than the perihelion summer, a relative difference of sixteen days in winter from the present perihelion winter; that, according to the meteorologist Croll, the winter of that period would be 10° or 15° colder than the present, but here really it would be 20° colder, according to the law of inverse squares in matter of *direct* rays of heat.

It will be remembered that Sir John Herschel and M. Pouillet, the French *savant*, by different methods found absolute zero to be 461° nearly, and stella space to be 239° below the zero of our thermometer (F), from which it appears the difference between 461° and 239°, viz., 222°, of our heat is due to the stars. Now, adding 23°, the temperature of New Hampshire in winter, to 239°, we have 262° due to the direct heat of the sun. The

aphelion distance of the sun being ninety-three millions, and the perihelion distance ninety millions, in round numbers, without taking into account our atmosphere, according to the law of inverse squares, the proportion $(93)^2 : (90)^2 \cdot\cdot 262°$ gives about 242° as the temperature of the aphelion winter, or 20° below the present. So taking the average winter temperature at 23° (it is 22.81° at Concord) at present, reduced by 20°, it gives a temperature of 3° above zero for the four winter months of that period.

Again: we have seen that the sun twelve thousand years ago went one degree further south, giving eight more of mid-winter days, and a relative difference of sixteen days from the present to be added to that aphelion winter with the accompanying meteorological conditions; from which I infer an additional reduction of at least 3° for the four winter months, making a temperature of zero for the aphelion winter.

Then, again: from the eccentricity being one half million of miles greater than now, the sun being more distant by that amount than now, I infer a reduction of 3° more for the winter months on that account. These estimates would give an average temperature of 3° below zero for the four, instead of three, as now, winter months. The annual temperature near the north pole, or, rather, as near as approached, is 5° above zero. We may have a faint idea of the climate of 3° below zero for a third of the year. The mean temperature for December, January, and February would be 26° below the present; and that of the four other months of winter, now about 40°, would be reduced at least 15°, and for the seven months, including winter, the average temperature could not be much above 10°. Now I think it plain in these estimates, not extravagant, that conditions of atmosphere would exist with the extra thirty-two days for winter that would reduce the temperature lower than I have here estimated. Considering the effect of a summer sun upon such an icy atmosphere and an icy surface, I can have no doubt the temperature of summer, although the sun was 3,500,000 of miles nearer than in the winter, must, through evaporation, condensing clouds, winds, and the general meteorological conditions consequent, have been reduced during those months much below the present temperature of summer, and

left the winter mantle of snow on the ground for the whole year, increasing from year to year until it exceeded the altitude of our highest mountains. No astronomer until Croll conceded that the eccentricity would have caused the icy climate necessary to produce the glacier; and none before him took into consideration the meteorological effects of such a winter upon the following summer.

While I believe these glacial conditions extended south to the Ohio, we must perhaps go back to those periods of greater eccentricity in aphelion winters to account for most of the phenomena of drift and boulders in this country as well as in Europe. But it is evident the precession period, which came once in 21,000 years, then, as now, was a part in producing the phenomena of those times.

But we have corroborative evidence of our position in the soil itself. In the precession period of 21,000 years, we must give a small half of it to a temperature fit for vegetation; and for vegetation of the present kind, we have a right to claim one third of the period; and it is evident that we have advanced more than half of the 7,000 years, or period of vegetation, in our state.

Soil is composed of the materials of disintegrated rocks, with decayed vegetable matter. Now fifteen inches is a sufficient estimate of the average depth to which vegetable matter can be traced in our soil, formed in place, not alluvial or drift. I will concede, though it is too small, an increment of .005 of an inch annually to the soil by vegetation. In a hundred years it would be half an inch, and in a thousand years five inches, and in three thousand years fifteen inches,—due to vegetable matter alone. We cannot, I think, in New Hampshire, give a greater age than that to vegetation of the present kind, even if so long. Our denuded hills then show us that three thousand years is sufficient time to account for all present vegetable growth in New Hampshire, since they escaped the erosive action of the ice sheet and glacier.

Let us digress here a moment, and turn to the future of a few hundred years. The sun is at the southern solstice the 21st of December, and at perihelion about the first of January, perihelion being about 10° on the ecliptic from the solstice. About

1250, as we have said, the winter solstice and perihelion were at the same point on the ecliptic. If we take that as the starting-point in the ecliptic, in 10,500 years from that time, or in the year 11,750, the aphelion winter will again come. We have then already passed 634 years towards it. Dividing 3,000,000, the present eccentricity, by one half of the period, viz., 10,500, we see we are going from the sun about 300 miles annually, and our climate is beginning to grow colder, and in about 10,000 years we shall reach the aphelion winter. We cannot then expect permanent improvement in our winters, since the sun is receding, and the cold will be perceptibly increased as time moves on; and the glare of the sun in summer will be proportionally increased in our latitude, but accompanied by denser clouds.

It is fortunate for us that we live in a perihelion winter in the middle of the precession period. We may lament for our successors,—of course we do for those of 10,000 years hence,—but the approach of the age of ice will be slow; they will have ample notice: the equator will then be but a few days distant, and long before the time the ice age shall set in they will move in crowds to the south, their descendants perhaps in ages to return.

Can you erect a monument that will resist the ravages of time and its accompanying destroying forces, to tell the future of 20,000 years of the race now inhabiting New Hampshire? All here now will, if anything, be fossil; and some geologist may trace out an ancient people from our cemeteries, as we do now from our Western mound-builders.

So much for our argument on temperature. In our study of the past conditions of climate we find a period, some twelve thousand years ago, where the temperature was cold enough to have caused constant congelation, and to have so continued many years; and we will now look to the product of those times,—the glacier. But how will we construct the glacier? To form an ice field, with a snow and ice covering several thousand feet thick, is very easy in the temperature we have reached.

Bordering on the Stekin river, in the southern part of Alaska, on the parallel of 57°, in July, 1875, a gentleman informs me he saw a glacier one thousand feet thick and a mile wide, extending far back into the mountains.

On Mt. Rainer, Washington territory, there are glaciers which are described by a traveller as more beautiful than those of the Alps. This is in latitude of 47°, a parallel less than three hundred miles north of ours.

To southern Greenland it is only a little further than to Chicago; and now let us bring Greenland down twelve hundred miles, and construct such conditions. The annual rain-fall here is forty-five inches: freezing it would be forty-eight inches (water expands in freezing), four feet. In a hundred years it would be four hundred feet, in a thousand years four thousand feet, and in two thousand years eight thousand feet, if not melting. If falling in snow, and we allow ten inches of snow for each inch of water, we have of the forty-eight inches of water four hundred and eighty inches or forty feet a year; in a thousand years forty thousand feet of snow, or an altitude, if not reduced by melting or pressure, of seven and one half miles or more. But we must suppose these conditions came by degrees, and it may have required six or eight thousand years. We have, then, all the elements and the factors of the snow mantle of enormous thickness,—the temperature, the snow, the ice, mountains, and ravines for the glacier.

What a dreary waste to contemplate! No vegetation, no bird or beast but those that live around the poles, which may have wandered here on the coast. Greenland to-day gives us an idea of such a condition, and we have only to travel north twelve hundred miles to reach a latitude of eternal snow. Greenland is represented to be an unexplored continent, buried under a "continuous and colossal mass of ice" that is moving slowly to the west to the sea.

This covering of snow and ice is by some estimated to be 4,000 feet thick, extending over an area of 1,000 miles long and 500 miles wide. When this moving mass reaches the coast it finds the ravines, and moves down as so many glaciers into the ocean, from 1,000 to 1,500 feet thick, carrying fragments of rocks and earth heaped upon it and frozen in it. And when far enough in the water to find a depth to swim, these glaciers break off into icebergs, and then, at the mercy of the sea, float down in some instances to our latitude.

Dr. Hayes and his party travelled some seventy miles in the

interior of Greenland, and he beautifully describes his visit as follows: "Our station at camp was sublime as it was dangerous. We had attained an altitude of 5,000 feet above the sea-level, and were seventy miles from the coast, in the midst of a vast frozen Sahara immeasurable to the human eye. There was neither hill, mountain, nor gorge anywhere in view. We had completely sunk the strip of land between the Mer de Glace and the sea, and no object met the eye but our feeble tent, which bent to the storm. Fitful clouds swept over the face of the full-orbed moon, which descending towards the horizon glimmered through the drifting snow that scudded over the icy plain, to the eye in undulating lines of downy softness, to the flesh in showers of piercing darts."

The French exploring expedition in the Astrolobe found an iceberg from 100 to 225 feet above water, and about five miles in length.

These are the productions, these are the conditions, we have found in New Hampshire a few thousand years ago. The movements of glaciers are known, and are described with accuracy. The Alps are studied, and the glaciers are the admiration as well as the wonder of the world, and from them the laws of the glacier applied to other similar phenomena that were unexplainable otherwise. These glaciers are not solid, compact ice throughout, but composed of every form of ice and snow, from the freezing to the frozen, from the minute particle to the massive block, from the round to the angular. They move slowly, owing to obstructions in their way,—a few feet perhaps in winter, but in summer more. Now in giving motion to the glacier we have only to apply the same cause that acts upon all bodies of ice, gravitation. If a solid mass of ice, its motion downward must be very slow if it has any; but the glacier in motion is not entirely of that description. We may suppose a glacier in a ravine; the effect of melting the surface would be to create a current, and the water with the particles of ice would flow down the surface till intercepted, or drop down to the bottom through some crevice and create a muddy stream there. But in the melting of those parts of the ice that were obstructed there would be no obstacle in the way, and the whole mass would move onward and downward by its own gravity. If the ice be what we

call in spring "soft," it would flow gently and constantly. The height of Mt. Washington is some 6,300 feet above the sea, or about an average of sixty feet to the mile. The running of water is quite perceptible with the fall of one inch a mile; and, applying the alternate heat and cold to the glacier, alternate freezing and thawing of portions of it, though slower, yet its own gravity must give it motion downward. We may see this principle in every thaw in the spring in some sudden melting of snow and ice; but raise these masses to immense proportions, and we have the work and movement of the glacier.

We may suppose this covering of snow and ice upon the plain of the Winnipiseogee, land-locked, hedged in by the Red Hills, Mounts Ossipee, Major, Gunstock, the Belknap hills, and other lofty hills upon every side, upon a plain twenty miles long and as many wide, and this at the close of a glacial age. The ice could not move *en masse*, and the only alternative nature gives is to dissolve the ice and let it pass off in another form. Much water from the dissolving mass will run over it, but most of it will run down the edges at the hillsides and under it, and some will find a crevice and bore through to the ground. The immense weight will press the ice deep into the thawing ground, and the percolating water will follow to reflow, charged with mud and clay, and flow off in the current.

It is the work of periods, not of a year or a hundred years;—but time is limitless to our mathematics, and this work requires only a division of time. As Lake Geneva was scooped out by the ice, so Lake Winnipiseogee was formed by the process of erosion, in the work of water and ice. So the Massabesic was dug out, and the sand, the clay, and the mud from these reservoirs,—the Winnipiseogee and others to the north,—were carried down by the currents of the river, and now form the terraces and banks of the Merrimack.

In the formation of river terraces all agree they are in part the work of erosion of an older formation. There are also sedimentary aggregations from erosions in other parts. At Hooksett falls there is the tearing away of an old barrier, a ridge that once extended from the Pinnacle across the river to the bluffs near, an obstruction of high elevation, with falls higher and grander than the Montmorenci of to-day—a reservoir flow-

ing back beyond Concord and receiving the muddy torrents laden with clay from the lakes to the north, to be deposited on the eastern shore, now so useful in business along the river. At the Amoskeag falls there are the remnants of an ancient cliff extending across the river, now worn down, but once high enough to flow the water over the intervening banks to Hooksett.

If there were an obstruction below Manchester of sufficient height (I think there must have been such) there would have been standing water on the plain of Manchester. In times of flood strong currents would flow through, with their pools and eddies on either side, flowing and reflowing and depositing the sand in its control, until the sand plain formed was left dry, upon which Manchester stands.

The picture of the ancient Merrimack would be beautiful indeed. Here a lakelet extending from Goff's falls to the higher Amoskeag, winding up the Piscataquog, and from the Amoskeag to the cataract at Hooksett,—thence north to Concord, and beyond, flowing the low lands adjoining,—a river of lakelets from a few rods to several miles in width, uniting only in falls or cataracts.

The clay came down in the muddy streams, as the rocks yielded to the disintegrating forces of alternate heat and frosts, when the curtain of the aphelion winter began to rise, and was gently deposited, little by little,—the sand, more sluggish in its course, following slowly behind,—while the huge boulder I have named floated down on the ice from the Epsom hills, and became stranded on the clay banks at Suncook.

We know that soil found upon the hillside is the decomposition of the older rocks there, with the addition of vegetable matter washed there, or blown there by the winds; and we know further, that some of this soil finds its way to the running stream, while the sides of the hill are left bare and rocky. The clay passes off in the stream in the form of mud, while the sand moves sluggishly; but if only a few feet a year, in a hundred and a thousand years the movement is mighty.

Our rocks are chiefly granite, gneiss, quartz, mica, feldspar, and sandstone of various kinds, and all have sand and clay in certain proportions. A hundred tons of quartz decomposed

would make as many tons of sand. In a hundred tons of feldspar, most easily decomposed by water and frosts, there would be 65¼ tons of sand, 18¼ tons of clay, and 14⅔ tons of potash; and in a hundred tons of mica there would be 46⅓ tons of sand, 36¾ tons of clay, 4½ tons of iron, and 9⅕ tons of potash, with other materials. Such are the proportions substantially as given by Lyell. So we have abundance of sand and clay in the decomposition of the rocks. Both move away from the parent rock; but clay moves so far and is so transformed as to have no resemblance to the family rock. These disintegrated rocks from lake and mountain, in the form of mud and sand, are the materials of which the Merrimack built its banks and terraces.

As we began with a view of the Merrimack river, its terraces, its banks of sand and clay, its boulders, its worn and torn down obstructions, in our study thereof we trace back to an age of cold, of snow and ice in glacial form, freezing, and bringing down the boulders, thawing again and bringing down the sand and clay, flowing and reflowing, forming banks and terraces, and channelling through the rocks, a cañon whose running waters give employment to thousands now, and hereafter will furnish labor and employment to millions more to come.

SOILING CATTLE,

OR

HOW TO BRING UP A BOUND-OUT FARM.

BY WILLIAM H. HILLS, OF PLAISTOW.

I.

Much is said at the present time about the silo and ensilage. Any man who has been feeding ensilage three weeks feels certain that he has settled the whole question of its present value and future permanent success. In his opinion it is not only the most economical food, but one that is eaten with a better relish than any other. It is more nutritious, and will make more beef when fed to the steer, and more and better milk that will yield more and better butter, when fed to the cow. It invigorates and gives tone to the system, glossiness to the coat, mellowness to the touch, elasticity to the step, brilliancy to the eye, and greatly improves the health and temper of the animal. It whets the appetite, aids digestion, promotes assimilation, and wards off disease.

This system has upset the tables of food values and the experiments in feeding at home and abroad, and sent a bomb-shell into the scientific camp, the sudden explosion of which fills the air with fragments of questions supposed to have been settled, mixed with the shattered remains of experimental stations, agricultural colleges, and chemical laboratories.

What does this state of things show? Just this—nothing more—that men go crazy over any *new* thing, if only it is backed by the extravagant statements of some wild and unscrupulous crank, who sells "Mammoth Ensilage Corn" at eight dollars a bushel, with a book telling how to grow it, at four dollars per

copy. They pass by unheeded more practical and important methods well suited to their condition.

Now, while I have no prejudice against the silo,—wish I had one, and if I can beg or borrow the money, may build one,—yet I think there is another system that may be more generally adopted on large or small farms than that about which we hear so much. I refer to the system of

SOILING CATTLE, ESPECIALLY MILCH COWS.

It is now more than sixty-five years since the honorable and venerable Josiah Quincy published his first essay on soiling cattle; more than thirty years since his second essay was written; and twenty-five years since both were given to the public in book form;—yet farmers and owners of small tracts of land are but just beginning to adopt the practice, and fully appreciate its advantages. This mode of feeding did not originate with Mr. Quincy, having long been practised in European countries, and only varied and modified by him to adapt it to our peculiar climate, crops, and condition.

Attention is called to this subject at this time, as it is believed that a large part of the land now devoted to pasturing can be put to other and more profitable uses. Land kept as a pasture merely, yields very little income. Much of our hilly and rocky soil is only fit for the growth of wood; and a good definition of a pasture, in many instances, would be, "a tract of land where cattle are starved and manure is wasted." In fact, the owner can afford to use none but poor, cheap tracts for grazing purposes, as the interest upon valuable land would make it too expensive.

"What is soiling cattle?" I hear some one inquire; and answer, It is simply the practice of feeding them in their stalls the year round, only allowing them air and exercise in the open yard every day when the weather will permit. This need be little more than the time required for watering, and putting their stalls in order; but one or two hours each day may be given when pleasant. Cattle have no inclination to remain out for a long time in the heat of summer, or in the chilly air of winter, if stables are properly constructed,—that is, cool, and somewhat dark in summer, and warm and light in winter. Cows will

always be found ready to return to their stalls, even before they can be properly cleaned and littered. By shutting out nearly all the light in summer, animals will be much less annoyed by flies, while a warm stable in winter will carry stock through in good condition, with less food, and insure better returns, than when their comfort is neglected.

The advocates of soiling claim, among other advantages, that they can,—

1. Keep a larger number of animals on the same area of land.
2. That it obviates the necessity of building and maintaining division fences.
3. That all waste of food is avoided.
4. That it adds to the condition, health, and comfort of animals thus kept.
5. That the yield of the dairy *for the year* is increased, and of more uniform quality.
6. That it adds greatly to the supply of manure, and thus,
7. It renders high manuring and improved agriculture possible.

Now it is certain that if half these advantages can be realized the system must be a good one, unless there are disadvantages to offset what is gained.

The only objections commonly named are "too much labor to grow the food and feed the stock, and want of exercise for the animal."

It may be well to answer objections at the outset.

My experiments have not been conducted on a large scale. I was driven to adopt the practice as a matter of necessity, having no pasture of my own, and being unable to hire at a reasonable price, within a reasonable distance.

I once paid ten dollars for pasturing a cow which had to be driven a mile and a quarter night and morning, and withdrew her before the season expired because the pasture contained nothing valuable for her to eat. I need not tell you that it is not half the work to feed a cow in the stall that it is to drive her this distance twice a day, or that the cow requires no such amount of exercise as a journey of two miles and a half daily besides that of roaming over a scanty pasture in search of food.

"But all pastures are not thus remote." This is true; and it is equally true that cattle in pastures near the farm buildings

move about but little simply for exercise. They eat and drink, and retire to the shade of some grove or tree, where they are tormented by flies, while they re-masticate their food and wait for the cow-boy to turn up.

After an experience of seven years, feeding only four or five animals, I would not accept as a gift the use of the best pasture half a mile distant, except for grazing stock turned out to remain during the season, as is the practice with young cattle and those to be fitted for beef. It is less work to feed a cow from some forage crops grown near the stable, than to drive her one fourth of a mile twice a day.

When I have kept but two or three cows, my neighbor, a dealer in cows, has kept from five to fifteen. I feed in the stable, and he feeds in a pasture a mile distant. I have good evidence that the quantity of my milk and butter exceeds, at times, the yield of his entire herd. It is but fair to say that he is not looking mainly to the dairy product as a source of profit, but rather to what the animal will sell for above its cost. As a cow is purchased one day and liable to be sold the next, no very systematic method of feeding is attempted.

The kind of exercise that the herd of cows referred to get I wish to avoid. They, with the cows of other owners, are driven past my residence morning and night, during the grazing season. They are almost always in the care of small boys, who loiter on part of the route, and make 2:40 time on the home stretch, in order to come under the wire in season to avoid inquiry. The boys are often mounted on horseback, and it is a question of speed and bottom between the horse and cows. Fortunately, the cows are always lean, in good racing condition, and not encumbered by udders filled with milk. Whips, stones, and a dog are used to urge the animals to and from the pasture. With a little training in a "go-as-you-please" race, any one of them might reduce the time of almost any horse on the turf. Some of the boys drive by the season, and their manner of fulfilling their engagement is by no means exceptionable.

It may be suggested, that while two or three animals can be fed by the soiling process with little labor, it would be otherwise with a larger number; but it must be apparent that the labor of growing fodder for and the feeding of ten animals will be less

in proportion than for the feeding of one or two. One cutting of forage will last for two or three days. If it wilts a little, all the better. When the fodder is in the stable, it is but little more work to feed ten cows than one.

Having answered these objections, I come to consider the advantages of the system.

1. *We may keep a much larger number of animals on the same area of land.* It has been found, by actual trial, that forage sufficient to keep one cow the year round may be grown on an acre of ground, and, in practice, that considerable less will suffice. Both Mr. Quincy, and Mr. A. W. Cheever, editor of the *New England Farmer* (who has for years and still continues to practise this system), have settled this matter beyond all question. Mr. Cheever has but twenty-six acres under cultivation, and has kept, at times, as many as thirty animals.

Don't let me be misunderstood: Mr. Cheever is in the dairy business, and feeds more or less grain, as all dairymen do,—as all do who feed ensilage. But he feeds no more than is required in feeding hay. His dry fodder is all grown on his farm. But, while Mr. Cheever cultivates only twenty-six acres of land, he grows sixty-six acres of crops, and says he has never worked his land to its full capacity. It will be seen that double and treble cropping must be practised. The rule is, never to let an acre of land lie idle a day. As soon as one crop is removed, re-seed with another. Grass may be cut in June, to be followed at once by Hungarian or fodder-corn, and these by winter rye or wheat.

The time required for a crop to arrive at its best condition must be carefully noted; and hence the importance of some experience before adopting this system on an extensive scale.

The short time required for forage crops to grow is seldom duly considered. Most of them will be fit for feeding in sixty days, and it is poor economy and bad farming to allow the land to lie idle, or grow up to weeds, after the early crops have been removed. Sow, harvest, fertilize, re-seed, and harvest again.

2. *It obviates the necessity of building and maintaining division fences.* Mr. Cheever has removed his fences, even on the highway. The saving of labor and expense in this particular is very great, especially where wooden fences are used. On many

farms the first cost of fences has been more than the farms are worth; and the annual expense of keeping them in repair is a serious tax upon the owner.

According to the census report for 1880, the cost of building and repairs of fences in this state in 1879 was $334,410. In his report for 1877, Secretary Adams gives the cost of the then existing fences of New Hampshire at $42,000,000. He found that there were 875 rods of fence for every 100 acres of land. According to estimates, there were $4,000,000 acres of land fenced, taking 35,000,000 rods of fence, costing $1.25 per rod, making the total costs, $42,000,000, as above stated. The annual interest on this sum is $2,520,000, to which add the annual cost of additions and repairs, as given by the census report, and we find the yearly expense of fences in the state amounts to the trifling sum of $2,854,410.

No man is morally or legally bound to fence his land for the benefit of his neighbor, or to protect his crops from four- or two-legged animals strolling lawlessly in the highway, or over his farm. All such trespassers should be taught that the right to pass over the public highway is all they are entitled to. What occasion, then, has the farmer for so many interior fences, cutting his land into plots of every conceivable size and shape? Such inclosures seldom contain more than a few acres, and often only a few square rods. The fences are in the way of convenient cultivation, and obstruct all the operations of the farm. The free use of the plow, harrow, cultivator, mowing-machine, hay-tedder, and rake is prevented, and all manure and crops must be hauled long distances, and useless bars and gates opened and closed hundreds of times every year, in consequence of the numerous fences which the farm contains. These otherwise useless divisions of land have been made mainly to enable the owner to shack his mowing-lands; and as that practice should be abandoned at once, it is another reason why the fences should be removed. But for these partitions there would be no excuse for half-plowed headlands, or the wide and wild hedgerows on either side that distinguish the slovèn from the thrifty farmer.

3. *All waste of food is avoided.* This proposition is self-evident, and needs only to be stated. If food is properly grown,

and fed in reasonable quantities, in its best condition, there will be absolutely no waste. Perfect economy of food is secured. This is not true under any other system of feeding. The usual practice is to feed a ration of some dry fodder in connection with the green every day, and also cotton-seed meal, shorts, or corn-meal in about the same quantities that are used with dry food alone. This is quite necessary when soiling on green corn, which is deficient in albuminoids and the fat-forming elements. It is an imperfect food for the production of muscle or milk, and cannot be fed alone successfully, either from the field or the silo. But we are not forced to resort to a grain ration to supply the defects of corn as food. Clover contains three and a half times as much albuminoids, or muscle-forming food, as corn, and four and a half times as much fat. According to German tables, corn contains a much smaller per cent. of albuminoids than any other food usually grown for feeding-grain, while clover stands at the head of the list, and is followed by pease, Timothy grass, rye, Hungarian, and oats, in the order named. Hence the importance of selecting for soiling purposes those crops that are complementary of each other, so that when fed together they will form a perfect food.

4. *It adds to the condition, health, and comfort of the animal.* Can there be any question that this statement is true? How many turn their stock away in the spring to be driven into the country, where they occupy some mountain pasture for months without care or protection, only to be returned in autumn when every vestige of herbage suitable for food has been blighted by frosts. I admit that this is the fate of the cow only when she is being fitted for the shambles. But the average treatment of cows, even in milk, is but little better. The pastures near home are, in fact, poorer than those in the country, and the cows are as much exposed to heat and cold, and sometimes storms, in one case as in the other. They often suffer for pure water and nutritious food, especially in time of drouth. They are tormented by flies, and worried and gored by each other, and the weaker animals are frequently permanently injured.

By the soiling system the supply of food is uniform, always abundant, and, if rightly managed, in sufficient variety,—a matter of no small importance.

The practice usually adopted is fully to stock the pasture in spring,—and in the flush of feed this is all right; but when the drought comes, as come it does every year, a supply of healthy, succulent food cannot be obtained, and the animal is forced to resort to the lowlands, and feed on the innutritious and worthless grasses and sedges there found, or browse on unpalatable, perhaps poisonous, shrubs, so common in all uncultivated lands. The milk and butter from a herd thus kept are unfit for the market or home use. Instances are not rare where cows at pasture all at once give a quality of milk and butter not simply off flavor, but utterly worthless for any purpose. It is often difficult to ascertain, and more difficult to remove, the cause of the mischief. It may arise from bad water, as in a dry pasture the cow is obliged to slake her thirst from any stagnant pool that her enclosure may chance to contain. I have known cows to be driven long distances for days and weeks to a pasture containing during no small part of the time absolutely no water whatever.

My experience in soiling has resulted in the perfect health of the animals soiled. There has been no case of disease or injury that could be attributed to this method of feeding, not even a case of garget (formerly quite frequent), horn-ail, or tail-sickness. The only exception that I could name would be a single case of milk (puerperal) fever, which some attribute to the high condition of the cow. Where any indisposition does occur, the animal, being every hour under the eye of the owner, can receive immediate treatment. In fact, I know of no place or circumstances in which a pet cow can enjoy such perfect serenity of mind as in a cool stall in fly-time, where her palate is tickled at least three times a day by the choicest food of the farm.

5. *The greater product of milk.* There can be no profit derived from a half-starved cow. In cases such as I have referred to, the milk and butter product runs down to zero, and no after treatment will restore it so as to give a profitable return. If kept in the stall and yard, both the kind and amount of food and water are under the entire control of the dairyman; and this system, it is obvious, must result not only in the greater comfort and better condition of the cow, but at the same time ensure a product more uniform in quantity and quality.

The owner of grazing land can be fairly certain of an abundance of grass for only a portion of our most favorable seasons. No prudent dairyman will fail to provide early in the season for the drought that is quite certain to make its annual visit. Unless forage crops are grown to be fed in their green state to supplement the deficiency in his pastures, he must suffer a great loss, as the milk flow can hardly be kept up, even by a liberal use of grain. A herd of cows, reduced in their yield at a season when it should be at its height, cannot be brought up again but by the best management and care; and the loss resulting will not be merely temporary, but permanent. With a full supply of cultivated forage crops growing near the stable, the dairyman feels independent of unfavorable weather. The parched and brown appearance of the pastures in August has no terror for him. The selection of his soiling crops, and the land on which they are grown, is so judiciously made that he is always sure of a supply.

There can be no denial of the fact that a cow on a good pasture, when food is flush, will give as much milk as when fed in the stall, and possibly the yield for a few weeks may be greater; but the product will not be so large and uniform throughout the year, nor during the summer months even. The change from the pasture to the barn cuts down the yield in autumn decidedly; but there is no such change noticeable when the cow has been soiled. My cows give milk the year round, and there is hardly any change in the quality or even the color of their butter perceptible.

6. *That the adoption of this system must add greatly to the supply of available manure is self-evident.* There is no such loss of manure as occurs when animals are turned to pasture during half of the year. Manure scattered over grazing land is of but little value to the soil, as it is not properly distributed, but lies in piles upon the surface, exposed to the elements by which it is very soon rendered almost worthless. The manure dropped on the way to and from the pasture, over highways, and through lanes, is an entire loss. When cattle are kept in the stall and yard there is no waste, but a perfect economy of manure; and, by a judicious use of absorbents, the yearly accumulation may be doubled or trebled.

It is not uncommon for dairymen to advocate and adopt a half-and-half method, feeding their herds morning and night on green food in their stalls, and turning them to pasture during the day. By this practice the advantages of the soiling system are in a great measure lost. There is just the same labor of driving the herd to and from the pasture, the same expense of building and maintaining division fences, the same exposure of the animal to annoyance by flies and the inclemencies of the weather, the same risk of injuries from tyrannical and vicious animals, and more than the usual loss of manure; for where cattle are not fed at all the manure dropped in the yard is the product of food consumed in the pasture, while, if fed in the stall and turned to pasture, the manure resulting from food grown under cultivation is carried to and scattered over dried-up grazing land, where it is an unavoidable and almost an entire loss. Better adopt the system in full, or not at all; or, at least, adopt it fully for a certain number of weeks or months in the hottest and dryest part of the summer.

The great want of the farmer is manure. Many farmers are yearly growing poorer, and smaller crops are grown from year to year, owing to a lack of manure. Fertilizers can be purchased in the market, but stable manure, in most localities, is not to be obtained. There are only a few, in the vicinity of cities and large villages, who can avail themselves of bulky manures, as it is too expensive to transport them long distances. Fertilizers are expensive, and the profits arising from their use go mainly into the pockets of the manufacturers and dealers. It would seem that any method of feeding that will double the quantity of manure on the farm is worth trying. I feel certain, from the statements of reliable persons who have adopted and still practice the soiling system with a large number of animals, as well as by my own experience in a small way, that the practice will produce a larger increase of manure than I have named. It will require very little or no money to try the experiment for a single year, and will cost no money or labor to abandon it if it does not prove a success. The trial involves no expense for the erection of additional buildings, or the purchase of costly machinery, as the ordinary farm implements are all that will be required.

WHAT CROPS TO GROW AND HOW TO GROW THEM.

It is true that manure or fertilizers will be required the first year in order to grow most of the food required for soiling; but if the practice is adopted gradually, with a few animals at first, and increased from year to year as the farmer becomes master of the method, little or no inconvenience will be felt. Winter rye for early spring feeding may be grown on burnt land, or elsewhere on land in fair condition, without manure, and grass and clover are available on all farms every year. They may be cut three times on good grass land, from the middle of May to the middle of October. These two crops will require no unusual application of manure. If corn for the silo can be grown at the rate of from twenty to seventy tons to the acre, with a rather small amount of manure, as some claim, then, to obtain sufficient forage for one cow, it would be necessary only to post a notice on your land of the quantity required in order to ensure a supply. But there is no occasion for drawing on the imagination in order to make out a case. It is said that ten tons of green clover to an acre is only a good crop at first cutting, and that twenty tons at three cuttings can as easily be grown as forty tons of corn. We have seen that clover is twice as valuable as corn, according to the German tables of food values. Whatever the maximum amount of green food that can be grown to an acre, as shown by the scales, may be, it will be found in practice that a surprisingly small plot of grass land, in high condition, will give a day's ration to a cow as early as the twentieth of May. Of course the grass at so early a date has not attained half its usual growth; but I have never found any trouble in obtaining a supply thus early. One fourth of an acre in grass or clover will support a cow from May 20 to July 1, and the same plot will give a second, probably a third, crop later in the season. Land that has been mown at any time before July first may be turned and sown to Hungarian, and give a heavy crop early in September; or a second crop of grass may be grown, as may be thought most advisable.

Winter rye will commence to head by May 20th, and must be used early, while tender, to be relished as a forage crop.

Corn will be the cultivated crop furnishing a larger amount of

green food than any other. Repeated sowings may be made from early in May till late in July, according to locality.

Oats and barley, alone or with pease, make a valuable green food. Barley is especially valuable, as it is more exempt from rust than any other of the small summer grains when sown late in the season. Oats, owing to their liability to rust, cannot be relied upon as a forage crop much after the middle of summer.

As to which kind of corn is preferable for green feeding is not well settled. The common Western corn is perhaps sown more generally than any other. It yields heavily, but the difference is not so great as many suppose, for our Northern varieties of flint or sweet corn can be planted much closer; and the stalks, being swollen, will be eaten with a better relish and without waste. There is this advantage in selecting the Northern varieties: the seed may be grown at home, which, where large areas are planted, will save quite an item of expense. If a surplus of seed is allowed to ripen, it will command a ready sale at remunerative prices. The seed dealers have been charging at least $3 per bushel for sweet corn for several years, and some years it can hardly be found at any price.

Mr. Cheever recommends planting a vigorous growing variety of ordinary field-corn, on rich land, as thickly as it will produce good ears. He has had large experience, and his opinion so fully accords with my own that I cannot forbear to quote a few sentences from one of his essays on feeding. He says,—"I found my field-corn producing this year at the rate of fourteen tons of fodder per acre (weighed after the stalks had become considerably dry, and the ears dry enough to husk for seed); while the same variety planted thickly, though weighing while very green two tons per acre more, was lodged badly, and the bottom considerably injured by rotting. When the field-corn was at its heaviest (the ears just beginning to glaze), a given area produced a much heavier crop than did the fodder-corn, and, fed with the ears on, was more relished by the cattle. Corn grown by field-culture thickly enough to produce ears is longer in fit condition to feed than if grown very thickly; while if there is a surplus, as there always should be to ensure against drought, the remainder left over after the season of green feeding is past will be much more easily cured, as well as more valuable for

winter storage. Until I find cause for changing my mind, I shall in future plant no corn specially for fodder in any of the popular ways, either broadcast or thickly in drills, but will plant for a full crop of ears, and not hesitate to cut it when it is most needed. I believe an acre of field-corn can never produce more flesh, milk, or butter than if cut when the kernels are just passing the milk stage, and beginning to glaze."

It will be seen that if Mr. Cheever is correct in his conclusions, of which I have no doubt, then the farmer need make no change in his method of growing field-corn, even though a portion of it may be wanted for fodder. In an attempt to grow a hundred bushels of corn on an acre a few years since, where the corn was planted rather thickly (three feet by two), I failed to obtain the number of bushels desired, but secured the heaviest crop of both corn and fodder that I have ever grown. The corn was cut early and shocked in the field, where it remained for a number of weeks uninjured by rain. The fodder was fed during winter to cows in milk, and to other stock, with the most satisfactory results. The advantages of growing corn so that the ears may mature, are, that we secure both a grain and forage crop at the same time, and there will be no danger of an oversupply.

The only objection to this method of growing corn for soiling purposes is, that it will occupy the land nearly if not quite all summer, while if cut green it may be followed by barley, spring rye, or wheat. Oats make a good soiling crop for summer, but are liable to rust, as before stated, if sown late. Some mix winter rye and barley, and sow in July or first of August. The barley will head out, and the rye will give a thick undergrowth and a fair crop of fodder or grain the next year. In this way the succession of crops may be so arranged that the land will not be allowed to lie idle a single day. Instead of producing half a ton of white-top *(Danthonia spicata)*, we may have many tons of more palatable and more nutritious food.

In sowing for forage we must first consider what area will be required to supply the number of animals to be soiled. One rod of grass, corn, oats, or barley has been found sufficient to afford each animal an abundant daily ration. Thus, an acre will support a cow 160 days, or five and one third months. In practice,

an acre to each animal will furnish sufficient food for six months, and often leave a surplus. But it is always safe to increase the area so that in no contingency shall there be any deficiency. As the surplus can be cured for winter use, it will be advisable for the beginner to sow an acre and a half for each cow.

The time required for each crop to arrive at suitable condition for feeding, and the length of time it will continue in best condition, are important matters for observation. Grass and corn will be available for a longer time than most other crops. Rye, oats, and barley soon become unfit for feeding green after they have attained full growth. They are best relished while tender and succulent. After a little experience, one can easily manage, by frequent sowing, to have plenty of food at all times in best condition for feeding. Arrange so as to give variety as much as possible. No animal likes to be confined to one kind of food for a long time; and hence it is advisable to sow two or more crops that will mature at about the same date. In such case, a less area of each is required. As a rule, each crop will be in best condition for ten days; after which it will become too far advanced to be eaten with good relish.

The first sowing should be of the most hardy crops on the earliest land. Oats, or barley with pease, may be sown on light land as soon as the frost is fairly out of the ground, as they are not likely to be injured by frosts; while corn can seldom be planted with safety before the first or middle of May in the southern part of the state, and later farther north and when the season is backward. It is better to risk a little with the first planting rather than delay too long. Corn is often injured in autumn, but seldom by spring frosts. Sweet corn is less hardy than the flint varieties, and will fail to germinate if the ground is wet and cold.

Millet is a valuable crop, both for feeding green and for curing as hay. It will not bear frost, but thrives best in the hot weather of midsummer. Thick seeding is usually practised with all soiling crops—three or four bushels of oats, etc., to an acre. A bushel of millet will not be too much for an acre, even if the seed is unmixed and fresh. To make sure on this point, purchase your seed early enough to test it before sowing. Count out and sow *in open ground* any number of seeds, and note the

result. The kitchen window and saucer method of testing seeds is not reliable: the conditions are too favorable. Seeds that will germinate fairly under such treatment may fail entirely in the field or garden. What I have said relative to the testing of millet-seed may apply to any purchased or doubtful seeds. I have purchased corn for planting, not more than fifty per cent. of which germinated under very favorable conditions. There is a great deal of venerable seed in the market every year. No dealer, of course, ever thinks of mixing old seed and new; but it is liable to get mixed by accident, and there can be no harm in testing its vitality. Pease do well mixed with the small grains, and make a very valuable food. They require deeper covering than grain, and for this reason should be sown and covered with a cultivator or some one of the wheel or other improved harrows. The small grain may be sown afterwards, and covered with the common harrow. We are told that the Thomas smoothing harrow may be used with advantage after the grain has attained four or six inches in height, destroying the weeds and doing the grain good. I have never tried the experiment.

KEEPING THE LAND AT WORK.

The importance of keeping the land constantly occupied by some growing crop cannot be urged too strongly. The tillage land of the average farmer is seldom expected to produce more than one crop in a year. There is no crop that requires more than four months to perfect its growth, and some of them only a few weeks, as is the case with the grass crop, millet, and the small grains, when cut or feeding green, or to be cured and stored as hay. Of course, grasses and the winter grains occupy the land for a longer time, but in a semi-dormant condition.

It is almost impossible to prevent cultivated land from producing something. If not otherwise occupied it will give us a crop of weeds that are worse than worthless. The farmer's land is his capital, and capital never should lie idle when it can be profitably employed. The production of remunerative crops is just that kind of employment for which the farmer's acres are adapted, and they should be constantly worked to their full capacity. What is the full productive power of an acre of land is a question never yet answered, as the limit has probably never

yet been reached. Mr. Cheever, who takes two and three crops from his "twenty-six acres" yearly, says he sometimes feels that he has hardly begun to realize their possible productive capacity. He says: "Two crops a year does not come quite up to my ideal. The acreage the past year as nearly as I can estimate has been nine acres winter rye, seven acres oats, five acres millet, four acres corn, four acres English hay (first crop), four acres rowen, nine acres barley (for fodder), one and one half acre for grain, one half acre winter wheat (part cut green and part left to ripen), one acre potatoes, five acres rye (sowed for next year's cropping), three acres barley (sowed with rye for this year's cutting) seven acres seeded to grass, and one acre in garden, in all sixty-six acres.

"The nearest approach I have ever made toward obtaining the full use of an acre of land through the whole year was with an orchard. It was sown with winter rye the previous fall, and the spring being early, it was ready to begin to cut and feed the first week in May. About the tenth it was finished, and the ground plowed, manured, and immediately sown to oats. You can readily believe that these were at their full height and in bloom the tenth of July. At this time they were cut and made into hay, the ground again plowed and manured, and sown to barley. The barley grew about two and a half to three feet high, was well headed and ready to cut the middle of September, or in season to be entirely out of the way of picking the winter apples, which made the fourth heavy crop of that season. I then had nearly the whole of October for seeding again with winter rye."

I quote this because it is the statement of an intelligent and perfectly reliable practical man, who keeps from twenty to thirty cows on an area of land that many would think too small to be called a farm. It also shows in what way some of the crops may follow each other, and the length of time required to produce them.

In my own case, feeding only in a small way, I have found grass on rich land, well stocked with the usual mixture of seed, the first crop available in spring. A quantity sufficient for the ration of one cow twenty-four hours may be cut from a square rod as early as the fifteenth of May, or five days before the

usual time of turning to pasture. The grass on such plots will be ready to cut a second time at the usual time of securing the hay crop, and will give a crop of rowen in September. Or the first cutting may be delayed till about the first of June, when the land may be plowed and planted to any farm crop, or sown for forage to be cut green in season for still another sowing, as, for example, to winter rye or wheat. The order of planting and sowing may be varied almost indefinitely, and success will largely depend upon good judgment and the knowledge acquired by experience. For this reason it is not advisable to adopt this system all at once, unless there is plenty of land to grow more food and a greater variety than will be found necessary when the routine of the practice has become familiar.

Soiling is especially adapted to land not well suited to grass, on lighter soils that are warm and easily worked. Corn, millet, and all the small grains, will flourish on such land. Whatever the soil, it must be liberally fertilized, for no one should attempt such heavy cropping without furnishing an abundant supply of plant food. The higher the condition the less area will be required, and the sooner the several crops will be available.

WINTER FEEDING.

For winter feeding my reliance has been upon the usual variety of dry fodder, with late cabbages grown for the purpose, beets, carrots, and when abundant, second grade apples. These, with feed and corn or cotton-seed meal, a warm stable, and kind treatment of the cow, and the proper management of her product in the dairy-room, will ensure good milk and a class of butter that will compare favorably with the lardine, suene, and oleomargarine found in the market.

ENSILAGE AS A WINTER FOOD.

I have no doubt that ensilage will be found to work well as a winter food to follow soiling in the summer. It may take the place of the root crop for winter feeding, and furnish an abundance of succulent food from fall to spring, and thus close a gap that it has been very hard to fill. Recent experiments show that cheap silos may be made to preserve green fodder just as well as the more costly structures, and also tend to show that

whole fodder may be preserved successfully, rendering the costly horse-power or steam-power and cutter unnecessary; and that whatever the cause of failure in a given case may be, it cannot be attributed to cutting the ensilage a sixteenth more or less than three eighths of an inch long. I am not one of those who believe that the silo can change the nature and add to the value of the material put into it: if it will preserve the contents in its best condition it will prove of great value. But it will be well for its advocates to remember that Roman wormwood *(Ambrosia artemisia folia)* and skunk cabbage *(Simplocarpus fœtidus)* put into the silo will come out nothing better than Roman wormwood and skunk cabbage. The ambrosia may be "the food of the gods," as its name indicates, but I do not think it will prove a valuable food for cattle. Food ensilaged *may* be rendered more digestible,—a question not yet settled,—but its feeding value is not likely to be otherwise increased.

PASTURING RENDERS LARGE AREAS OF LAND INDISPENSABLE.

It must have occurred to every man who occupies fifty acres to ten cows during the grazing season, and in that proportion for a larger or smaller number, that there must be something wrong in a system which makes such a tract necessary. Some may think that five acres is too high an estimate for the wants of a cow, but the dairy districts of New York average not less than six acres. It will be seen at once that pasturing cannot be practised with profit on land worth $100, and more, per acre, unless the acre can be made to support a cow for the season. This is seldom if ever done. Food sufficient for a cow the entire year may be grown on an acre, if the acre can be made to produce fifteen tons of green fodder at one cutting, and this may easily be done. I have no doubt that thirty tons of green corn-fodder are sometimes grown, and we are assured by parties who are noted for brilliancy of imagination that there is no trouble in growing fifty and even seventy and ninety tons to the acre for ensilage.

The cost of growing a soiling crop is sometimes urged as the great objection to the soiling system; but if green fodder can be grown, cut, and packed in the silo at from $1.50 to $2 per ton,

as we are assured it can be, then the matter of cost is not worth naming.

THE GENERAL ADOPTION OF THE SYSTEM.

It is not likely that the soiling system will ever be generally adopted. There are thousands of acres of land in this, as in other states, only adapted to grazing and the growth of wood, and it is perfectly proper that such lands should be utilized for these purposes. But I think the indiscriminate slaughter of our forests, in many instances burning valuable wood and timber on the ground for the mere purpose of fitting the land for grazing, should at once cease. The owners of such forests should be taught that there is another method of feeding even large herds, less destructive, wasteful, and expensive.

The general adoption of the practice of stall-feeding dairy cows only would render large pastures useful only for growing and fattening animals that can be turned out for the summer, and require comparatively little care; while it will enable the owner of small tracts of land suitable for tillage to keep one or more cows with profit, where, under the old system, it would be impossible. Many mechanics, and others whose families are deprived of or poorly supplied with milk and butter of fair quality, might enjoy an abundance at much less cost than if purchased in the market. In the vicinity of small villages, pastures are not to be obtained, or, if at all, only at exorbitant prices. The only alternative is to abstain entirely, or rely upon such products of the dairy as come to hand, however unfit for use. Miserable butter and filthy or adulterated milk have come to be the rule with a majority of consumers, and not the exception.

A DILEMMA SOLVED.

Writers and speakers are constantly urging farmers to keep more stock; but how is this to be done while they have not a sufficient supply of food for the animals already kept. It is equally useless to urge the growing of larger and more varied crops, while we have not half manure enough to properly fertilize those already grown. We grow small crops because we lack manure with which to produce those that are larger. We are short of manure, as we do not keep a sufficient number of ani-

mals to furnish a supply. We do not keep the requisite stock, because we have not the food to keep more from starvation. We have not the stock, the food, or the manure, because we have not the money with which to purchase either; and we could not find the stable manure if we had the money. In short, there are too many farmers out of hay, out of stock, out of manure, and out of money. They ask, What can we do?—and are coolly told that they must keep more stock, make more manure, and raise bigger crops. They are very much in the condition of the man, during the last season's drought, who was mourning because he was out of water. He said he would not mind it so much, but he was out of rum at the same time.

At a recent agricultural meeting I heard a lecturer,—a very intelligent man, too,—urging the farmers present to keep more stock in order to make more manure with which to increase the fertility of their farms and grow better crops. In answer to the question, "How can we keep more stock?" he replied, "The way to keep more stock is to keep it." This being an original and brilliant idea, brought down the house.

The truth is, that the farmer without money, etc., is in a sort of tread-mill, where he can neither stop nor advance. If he could have any one of his wants supplied, he might strike out in a right line and make visible progress.

Where, then, shall the beginner start? I venture to suggest, With the purchase of fertilizers. It will not pay, as a rule, to purchase feeding-stuff simply for the purpose of making manure. Fertilizers are always available. Get trusted for a few hundred pounds for two or three months, if you can do no better. A small outlay will give you a valuable forage-crop in return. Grow your fodder, feed your cow, make the manure for a second crop, grow another, feed what is wanted green, and cure the surplus for winter use; invest the proceeds of the milk and butter not wanted in the family, if any, in shorts and cotton-seed meal; use absorbents, such as soil, muck, and gypsum in the stables, sties, vaults, and sink-drains; keep your land constantly at work; work lively yourself every day, and smoke evenings, if you must smoke,—but do n't use tobacco at all. The money saved every year will buy fertilizers for an acre, and the money that you formerly paid for chalk and water and oleomargarine

will purchase enough for two acres more. Having got the wheels fairly in motion, there will be no trouble in raising fodder, keeping stock, and making manure.

Mr. Quincy estimated his manure at one buck load per month per head, or six loads for each head for the six soiling months. Absorbents were used, by means of which the liquids as well as solid manure were saved. The value of the manure much more than paid for the labor of growing and feeding the food and the entire care of the cattle. It should be borne in mind that only the extra labor of growing and feeding soiling crops is chargeable to this method, as all other trouble and expense attending the general care of a herd of cows would occur under any practice. By soiling we avoid all annoyance from breachy animals, and if we take into account the time and expense saved in the building and keeping in repair pasture and interior fences, and in driving animals to and from pastures more or less distant, and also the convenience of having an abundance of manure made on the farm where it is accessible at all times for immediate use, the advantages of this process will be at once apparent.

EXPERIMENTS AT ROTHAMSTED.

ABRIDGED FROM DR. MANLY MILES, IN POPULAR SCIENCE MONTHLY.

BY THE SECRETARY.

The reading farmer is familiar with the names of Lawes and Gilbert. The acquaintance which the American cultivator has made through these men with scientific agriculture only creates a desire for a more extended knowledge of their history and their works.

John Bennett Lawes was born in 1814, in the county of Hertfordshire, England. His literary and scientific education was received at Eaton and Brasenose college. Leaving the university of Oxford at the age of twenty-one, he devoted much time to his favorite study, chemistry, in the city of London. Prior to this time, at the age of ten years, he had succeeded to an estate in the town of Rothamsted, near Harpenden station, on the Midland Counties Railway, about twenty-five miles from London. It was not until after his graduation that he took the management of his estate, although he came into full possession of it at the age of twenty-one.

His first work was a series of experiments with fertilizers, first in pots, on a limited scale, and then in the open field, which he has continued to the present day. The results of these and other experiments in the interests of agriculture have been published wherever the English language is spoken, and have been translated largely into French and German, and are known the world over.

In 1843 Dr. J. H. Gilbert was associated with Dr. Lawes, and for forty years these men, at the expense of the latter, have

patiently labored in the cause of science as practically applicable to agriculture. At this date the work had assumed such proportions as to require the personal attention of one man, and Dr. Gilbert was the man for the place.

From the date of Dr. Gilbert's association with Dr. Lawes, Rothamsted has been an agricultural experimental station, but unconnected with any organization. The services of these men have been officially recognized, not only by the English government and scientific institutions of Great Britain, but by foreign governments and institutions. The emperor of Germany by imperial decree awarded the gold medal of merit, and the Imperial agicultural society of Russia conferred its gold medal; and Dr. Lawes has recently been constituted a baronet, and is now known as Sir John Bennett Lawes.

This great benefactor of agriculture is expending $15,000 a year of his private fortune, and has set aside the sum of £100,000, or a half million dollars, to complete the work when he is no longer able to direct it.

In the laboratory are now preserved more than thirty thousand bottles of experimentally grown produce, animal products, ashes, and soils. More than one thousand samples of soils have been taken from different depths in order to determine the rate of exhaustion. The rain-fall has been accurately measured for a period of thirty years, the amount of nitrogen in rain water has been ascertained, drainage water has been analyzed, and experiments made of crops grown on sewerage fertilization. Extended experiments have also been made in feeding animals and in fattening them. In short, the work is incalculable, and commends itself to every progressive farmer.

Without permission from the author or publisher, we have condensed the extended paper of Dr. Miles, and taken from it liberal extracts for the benefit of those who will never be in a situation to read the valuable papers of these English experimenters, nor be likely even to have access to the chapters of the *Popular Science Monthly*.

CROP EXPERIMENTS.

"The general scope and plan of the field experiments has been to grow some of the most important crops of rotation, each

separately, year after year, for many years in succession on the same land, without manure, with farm-yard manure, and with a great variety of chemical manures; the same description of manure being, as a rule, applied year after year on the same plot. Experiments on an actual course of rotation, without manure and with different manures, have also been made. In this way experiments have been conducted as follows:

"With wheat, thirty-nine years in succession: thirteen acres, thirty-seven plots, many of which are duplicates of others. On barley, thirty-one years in succession: four and a half acres, twenty-nine plots. On oats, ten years (including one year fallow): three quarters of an acre, six plots. On wheat, alternated with fallow, thirty-one years: one acre, two plots. On different descriptions of wheat, fifteen years: four to eight acres (each year in a different field), now more than twenty plots. On beans, thirty-two years (including one year wheat, and five years fallow): one and a quarter acre, ten plots; also twenty-seven years: one acre, five plots. On beans, alternated with wheat, twenty-eight years: one acre, ten plots. On clover, with fallow or a grain-crop intervening, twenty-six years: three acres, eighteen plots. The land is now devoted to experiments with various leguminous plants, commenced in 1878. On turnips, twenty-eight years (including three years barley): about eight acres, forty plots. On sugar-beets, five years: about eight acres, forty-one plots. On mangel-wurzel, seven years: about eight acres, forty-one plots. On potatoes, seven years: two acres, ten plots. On rotation, thirty-five years: about two and a half acres, twelve plots. On permanent grass-land, twenty-seven years: about seven acres, twenty-two plots.

"Comparative experiments, with different manures, have also been made on other descriptions of soil, in other localities. Samples of all the experimental crops are taken, and brought to the laboratory. Weighed portions of each are partially dried, and preserved for future reference or analysis. Duplicate weighed portions of each are dried at 100° C., the dry matter determined, then burned to ash on platinum sheets in cast-iron muffles. The quantities of ash are determined and recorded, and the ashes themselves are preserved for reference or analysis. In a large portion of the samples the nitrogen is determined,

and in some the amount existing as albuminoids, amides, and nitric acid.

"In selected cases—illustrating the influence of season, manures, exhaustion, etc.—complete ash-analyses have been made, numbering in all more than seven hundred. Also in selected cases, illustrating the influence of season and manuring, quantities of the experimentally grown wheat-grain have been sent to the mill, and the proportion and composition of the different mill-products determined.

"In the sugar-beet, mangel-wurzel, and potatoes, the sugar in the juice has in most cases been determined by the polariscope, and frequently by copper also.

"In the case of the experiments on the mixed herbage of permanent grass-land, besides the samples taken for the determination of the chemical composition (dry matter, ash, nitrogen, woody fibre, fatty matter, and composition of ash), carefully averaged samples have frequently been taken for the determination of the botanical composition. In this way, on four occasions, at intervals of five years—viz., in 1862, 1867, 1872, and 1877—a sample of the produce of each plot was taken and submitted to careful botanical separation, and the percentage, by weight, of each species in the mixed herbage determined. Partial separations, in the case of samples from selected plots (frequently of both first and second crops), have also been made in other years."

The quantity and composition of drainage-waters under various conditions have been the subject of elaborate and extended experiments for many years, and the results obtained are of the greatest importance.

In 1870 three "drain-gauges" were made, each having an area of one thousandth of an acre, and inclosing the soil and subsoil in a natural state of consolidation to the depth of twenty, forty, and sixty inches, respectively. As the surface-soil in these gauges is kept free from vegetation, and no fertilizers are applied, their drainage represents, in effect, that of a bare, unmanured fallow. In the separate drains of the permanent wheat-plots, facilities were provided for collecting samples of drainage-water from soils growing crops without manure, with barnyard manure, and with a great variety of chemical manures.

Determinations of the nitrogen in rain-water were made at Rothamsted as early as 1846. The ammonia in the rain-fall for fifteen months, in 1853–'54, was determined in the laboratory at Rothamsted, and again in 1855–'56 by Professor Way.

Experiments were made for several years with plants representing the gramineous, the leguminous, and other families, and also with evergreen and deciduous trees, to ascertain the amount of water given off during their growth.

Observations on the character and range of the roots of different plants, the relative development of leaf and stem, and their composition at various stages of growth, have been made in connection with experiments to determine the differences in the amount and constituents assimilated by plants of different botanical families, under similar conditions, and of the same plant under varying conditions. From these investigations, so far as they have been published, it appears that the chemical relations of the plant and soil are, to a great extent, determined by botanical and physiological conditions.

In the experiments with the mixed herbage of "permanent meadow," for example, it was noticed, even in the first years of the experiments, that "those manures which are most effective with wheat, barley, or oats grown on arable land—that is, with the gramineous species grown separately—were also the most effective in bringing forward the grasses proper in the mixed herbage; and again, those manures which were the most beneficial to beans or clover, most developed the leguminous species of the mixed herbage, and *vice versa*"

In the produce grown continuously without manure the average number of species was forty-nine. Of these, seventeen are grasses, four leguminous species, and twenty-three of other orders. By weight the grasses averaged sixty-eight per cent., leguminous species nine per cent., and species of other orders twenty-three per cent.

In the produce of the plot most heavily manured and yielding the heaviest crops, the average number of species was nineteen; of which twelve to thirteen were grasses, one only (or none) leguminous, and five or six only of other species. By weight the grasses averaged about ninety-five per cent., the leguminous species less than 0.01 per cent., and other orders less than five per cent.

On the plot receiving annually manures that are of little avail for gramineous crops grown separately in rotation, but which favor beans or clover so grown, the average number of species was forty-three, of which seventeen were grasses, four leguminous, and twenty-two belonging to other orders. But by weight the grasses averaged but from sixty-five to seventy per cent., the leguminous species nearly twenty per cent., and all other species less than fifteen per cent.

The "struggle for existence" and the "survival of the fittest," therefore, determine the character of the species contained in the produce under the conditions, and the chemical composition of the crop varies accordingly. With an increase of the leguminous produce the nitrogenous constituents are increased, and with a decrease in the leguminous produce the nitrogenous constituents are diminished.

Experiments with leguminous, gramineous, and other families of plants were made for several years in succession, at Rothamsted, to determine whether plants assimilate free or uncombined nitrogen. The relations of nitrogen to the growing plant and to the soil, and the sources of the nitrogen of vegetation, have been prominent subjects of investigation in all the Rothamsted field experiments.

It is not my purpose, in this connection, to discuss the various theories of vegetable growth, or to give an account of the many controversies that have arisen in the developmental progress of science, but simply to call attention to some of the leading lines of investigation at Rothamsted, which have had an influence in correcting our theories of vegetable nutrition and soil exhaustion and in improving our methods of agricultural practice.

The legitimate aim of all systematic, exact experiments is to lay a foundation of well-ascertained and closely-related facts on which may be developed a superstructure of science to supersede the theoretical speculations which form an important part of the prelude of scientific discovery. In this work of reconstruction, Drs. Lawes and Gilbert have for many years occupied a prominent position, and a full account of their labors would involve in the record a history of agricultural science for the past half century.

From an agricultural stand-point one of the first steps in the

study of the laws of plant growth and nutrition is to ascertain the relative influence of the soil and the air in the supply of plant-food, as they are the only sources from which plants obtain the elements which enter into their composition.

The atmosphere is a mixture of gases, of which more than three fourths is nitrogen and less than one fourth oxygen, with something less than one part in ten thousand of carbonic acid In addition to these there are traces of ammonia and a variable quantity of vapor of water.

As the carbon, which forms about one half of the dry substance of plants, is all derived from the minute proportions of carbonic acid found in the atmosphere, it has been assumed that the comparatively small amount of nitrogen required by plants could be readily obtained from the abundant stores of this element in the atmosphere, and that wide-leaved plants, like clover and beans, could more readily assimilate it than those with narrow leaves, like the grasses.

Experiments by Boussingault and the elaborate researches at Rothamsted, however, show that free nitrogen, the most abundant constituent of the air, is not assimilated by plants. The atmospheric sources of nitrogen for plant-growth must, therefore, be limited to the minute quantities of combined nitrogen in the form of ammonia and nitric acid. Important data as to the amount of nitrogen in various field-crops, grown under a variety of conditions, and the sources from which it is obtained, are furnished in the Rothamsted field experiments.

For a period of thirty-two years, wheat, on plots without manure, yielded an annual average of 20.7 pounds of nitrogen per acre. The yield, however, declined from an average of more than twenty-five pounds during the first eight years, to an average of but sixteen pounds during the last eight years of the experiment.

Barley, for a period of twenty-four years, on plots without manure, yielded annually an average of 18.3 pounds of nitrogen per acre, with a decline from an average of twenty-two pounds over the first twelve years to an average of 14.6 pounds over the next twelve years. Mineral manures, containing no nitrogen, applied to barley and wheat, did not materially increase the yield of nitrogen in the crop.

A succession of root-crops (with three years of barley intervening after the first eight years), dressed with a complex mineral manure, yielded an average of 26.8 pounds of nitrogen per acre, per annum, over a period of thirty-one years; with a decline from an average of forty-two pounds over the first eight years to 13.1 pounds (in sugar-beets) over the last five years. Afterward, with the change of crop to mangels, the yield of nitrogen was somewhat increased.

Beans, for a period of twenty-four years, yielded an average of 31.3 pounds of nitrogen without manure; and, with a complex mineral manure, an average of 45.5 pounds of nitrogen per acre. The decline in yield of nitrogen was, however, from an average of 48.1 pounds over the first twelve years to only 14.6 pounds over the last twelve years, when unmanured, and from an average of 61.5 pounds over the first twelve years to but 29.5 pounds over the last twelve years, when mineral manures were applied.

An annual average yield of nearly two hundred pounds of nitrogen per acre was obtained in the clover grown for twenty-seven years in succession on a plot of old garden-soil that was exceptionally rich in nitrogen at the beginning of the experiment. As in the case of other crops, there was a marked decline in the average yield of nitrogen in the last half of the period, and there was also a great reduction in the stores of nitrogen contained in the soil.

The leguminous crops, beans and clover, it will be seen, contain a larger amount of nitrogen per acre than the gramineous crops, wheat and barley. In the Rothamsted experiments it was, however, found that manures containing nitrogen benefited the gramineous crops, while they had but little, if any, influence upon the growth of leguminous crops. The chemical composition of the crop was not, therefore, an index of the manurial constituents required to promote its growth.

When turnips, barley, clover, or beans, and wheat were grown in rotation for twenty-eight years, the average annual yield of nitrogen per acre was 36.8 pounds, and in the mixed herbage of permanent grass-land, when unmanured, the annual yield of nitrogen averaged thirty-three pounds per acre.

The larger average yield of nitrogen per acre in the crops in

rotation and in the mixed herbage of the permanent grass-land, as compared with the yield of nitrogen in gramineous crops when grown separately, is not entirely due to the larger amount of nitrogen in the leguminous species themselves, but also to their influence upon the gramineous species which are able to take up and assimilate more nitrogen when the highly nitrogenous leguminous crops have been appropriating their larger supplies of the same element, as will be seen from the following experiments:

"In alternating wheat and beans, the remarkable result had been obtained that nearly as much wheat and nearly as much nitrogen were yielded in eight crops of wheat in alternation with the highly nitrogenous beans, as in sixteen crops of wheat grown consecutively without manure in another field, and also nearly as much as were obtained in a third field in eight crops, alternating with a bare fallow.

And again: "After the growth of six grain-crops by artificial manures alone, the field so treated was divided, and in 1873 on one half barley, and on the other half clover, were grown. The barley yielded 37.3 pounds of nitrogen per acre, but the three cuttings of clover yelded 151.3 pounds. In the next year, 1874, barley succeeded on both the barley and the clover portions of the field. Where barley had previously been grown, and had yielded 37.3 pounds of nitrogen per acre, it now yielded 39.1 pounds; but where the clover had previously been grown, and had yielded 151.3 pounds of nitrogen, the barley succeeding it gave 69.4 pounds, or 30.3 pounds more after the removal of 151.3 pounds in clover than after the removal of only 37.3 pounds in barley."

We will now examine some of the evidence furnished by the Rothamsted experiments, in regard to the sources from which the nitrogen of field-crops is obtained.

As free or uncombined nitrogen cannot, as we have seen, be assimilated by plants, we will next consider the supply of combined nitrogen in the form of ammonia and nitric acid, existing in the atmosphere.

From the earlier investigations of the rain-fall at Rothamsted and likewise on the Continent, it was estimated that from eight to ten pounds of combined nitrogen per acre was precipitated

annually in the rains of western Europe. Later observations at Rothamsted show that this estimate is probably too high, and Drs. Lawes and Gilbert, after a full discussion of their records for twenty-seven years, fix the probable amount at four to five pounds per acre.

As this is only one fourth of the average annual yield of nitrogen per acre of the unmanured wheat over a period of thirty-two years, and but little more than one fourth of the average annual yield obtained with barley over a period of twenty-four years, to say nothing of the much larger yield of nitrogen in leguminous crops, it must be admitted that it is an entirely inadequate source of supply of nitrogen for vegetation. The nitrogen condensed by the soil from dew and atmospheric vapor has not been definitely determined, and is not, therefore, included in this estimate; but it is probable that it is less than that brought to the soil by the rain. On the other hand, it has been shown by numerous experiments, including those at Rothamsted, that free nitrogen is evolved in the decomposition of organic matter, and that the soil, under certain conditions, may suffer a loss of nitrogen in this form.

Of the rain falling upon the drain-gauges, the unmanured soil of which, it will be remembered, is in a natural state of consolidation and kept free from vegetation, for a period of ten years, about forty-four per cent. has appeared as drainage-water, and about fifty-six per cent. has been evaporated. Approximately, two thirds of the evaporation takes place during the summer months, and one third during the winter months.

The annual loss of nitrogen in the drainage-water has been, upon the average, at the rate of 43.7 pounds per acre. This represents, approximately, the loss involved under the conditions of a bare summer fallow.

When the roots of growing plants are distributed through the soil, they take up the nitrogen as it becomes soluble in the process of nitrification, and the loss by drainage is to that extent diminished.

The drainage from the unmanured wheat-plots contained nitrogen at the rate of only from 12.56 to 18.62 pounds per acre each year, and during two seasons of excessive drainage, when every running from the drains was analyzed, "it was estimated that

from fifteen to seventeen pounds of nitrogen were lost per acre, per annum, by drainage from plots which had received no nitrogenous manure for many years," and the average for thirty years was from ten to twelve pounds per acre. During its period of active growth, the crop appropriated the nitrogen of the soil, so that there was little or none lost by drainage, and nearly the entire loss took place after harvest, and during the winter and spring months.

The nitrogen lost by drainage on land receiving no nitrogenous manure is therefore considerably more than can reasonably be estimated in the supply from atmospheric sources.

When nitrogenous manures were applied, the loss of nitrogen by drainage was materially increased, and on the average for more than thirty years, and under the most favorable conditions of growth, less than one third of the nitrogen applied as manure was recovered in the increase of the crops, and much less than this when there was a deficiency of potash or phosphoric acid in the soil.

In connection with these facts, relating to the amounts of nitrogen removed in the crops and lost by drainage, and the inadequate supplies of available atmospheric nitrogen for the purposes of plant-growth, it becomes a matter of particular interest to trace the influence of this system of continuous cropping, without nitrogenous manures, upon the nitrogen contained in the soil itself.

The nitrogen in the soil of the unmanured wheat-plots has gradually diminished, and Dr. Gilbert says,—"So far as we are able to form a judgment on the point, the diminution is approximately equal to the nitrogen taken out in the crops, and the amount estimated to be received in the annual rain-fall is approximately balanced by the amount lost by the land, as nitrates in the drainage-water."

Where the great decrease in the yield of nitrogen was observed, in the case of the root-crops which were grown for thirty-one years in succession, the soil at the end of twenty-seven years was found to contain a smaller percentage of nitrogen than any other arable land of the farm.

In the experiments on the mixed herbage of permanent grassland "the soil of the plot which, under the influence of a mixed

mineral manure, including potash, had yielded such a large amount of leguminous herbage, and such a large amount of nitrogen, showed, after twenty years, a considerably lower percentage of nitrogen than that of any other plot in the series."

The soil of the garden-plot, which gave so large a yield of clover over a period of twenty-seven years, was analyzed at the end of twenty-six years, and Dr. Gilbert remarks, in regard to the loss of the nitrogen of the soil, that "the diminution, to the depth of nine inches only, represents, approximately, three fourths as much as the amount estimated to be taken in the clover in the intervening period; and the indication is, that there has been a considerable reduction in the lower depths also."

When nitrogenous manures were applied in the form of ammonia salts or nitrate of soda, there was little or no decrease in the nitrogen of the soil, and in some cases there was an actual gain; but the loss from drainage was much greater, and it increased with each increment of the manures applied under the same conditions. On plots receiving 43, 86, and 129 pounds, respectively, of nitrogen in the form of ammonia salts, mostly applied in the autumn, the estimated loss of nitrogen by drainage was 19, 31, and 42.4 pounds; "and with 86 pounds of nitrogen applied without, or with different mineral manures, the estimated loss ranged from 31 pounds with the most liberal manure to 43.2 pounds with the ammonium salts continuously used alone."

The nitrogen of barnyard manure, which from its comparative insolubility is more slowly available for purposes of plant-growth, was not lost by drainage to the same extent as the chemical manures, and there were decided indications of considerable accumulations of it in the soil. The nitrogen applied in manures is not all accounted for in the amounts removed in the crop, lost by drainage, and stored up in the soil; and it therefore seems probable, in the absence of any other known disposition of it, that the estimated losses by drainage, based on the materials discharged by the tile-drains, are altogether too low. As the drainage-waters, with the substances they hold in solution, pass from the upper to the lower strata of the soil, we cannot avoid the conclusion that a large proportion must pass

below the level of the drains without entering them. The drains of the experimental wheat-fields are nearly twenty-five feet apart, and the underlying chalk at the depth of from ten to fourteen feet furnishes good drainage for the spaces between the drains.

The nitrogen applied in the manures, that is not taken up by the crop, or stored up in the soil, or lost in the waters discharged by the tile-drains, may therefore be fully accounted for in the amount that must be carried, under the conditions of the experiments, by the drainage-waters to the lower strata of the subsoil, without entering the drains. The estimated losses of nitrogen by drainage, based on the amounts detected in the waters discharged by the drains, may therefore with good reason be increased by the amount not accounted for in the crop and in the accumulations of the soil.

Practically, then, in the light of the Rothamsted experiments, we may look upon the soil as the great source of the nitrogen of plants, as the atmosphere can furnish but a small proportion of the needed supply, and this is more than counterbalanced by the losses from drainage.

In connection with this imperfect outline of some of the leading lines of investigation that have been so successfully prosecuted at Rothamsted, it would be interesting to examine the data that indicate the relations of nitrogen to other elements of plant-growth, as supplied in manures and assimilated by crops when cultivated in succession or in rotation with other species; but these, with other cognate topics, must be omitted, as we cannot at this time undertake anything like an exhaustive discussion of the results of these valuable experiments.

The great importance of physiological researches and the comparatively subordinate influence of purely chemical methods in solving the great problems of agricultural science, have been so fully illustrated in the experiments at Rothamsted that we must accept them as the basis of a new departure in the development of a consistent science of rural economy. In the light of these experiments the generally accepted theories of soil exhaustion must be reconstructed, and the action and relative value of manures must be investigated from a new stand-point.

The exhaustion of a soil can no longer be estimated by the

constituents removed in the crop. Wheat and oats, with other cereals, are generally considered as exhausting crops, and a summer fallow is looked upon as a means of increasing or restoring the fertility of the soil; but the grain-crops when grown by themselves, and the summer fallow itself, are alike the occasion of a loss of fertilizing materials, and in precisely the same way. In both cases there is a long interval in which there are no living roots of plants in the soil to take up the nutritive materials as they are transformed into the soluble form, and they are lost by percolation to the lower strata of the subsoil out of the reach of vegetation.

Many of what are called restorative plants feed in the deeper layers of the soil, and they may, by their scattered foliage and thick roots, add to the stores of plant-food in the surface-soil, which may be used by plants of a different habit that are not deep feeders.

The physiological peculiarities of the different botanical groups of plants must, however, be better understood before we can fully explain the influence of one crop upon another that succeeds it. That the special formula manures, so widely advertised in this country, and which are claimed to provide, in due proportion, the constituents required by a particular crop, are based on false assumption, is abundantly shown in the Rothamsted field experiments; but we cannot now discuss the fallacy in detail.

ANIMAL EXPERIMENTS.

From Dr. Miles's second article in the same journal, we copy his statements in regard to experiments in feeding, its result on the animal and on the manure:

In determining the amount of food and of its several constituents consumed for a given live weight of the animal in a given time, and the amount of food and of its several constituents required to produce a given amount of increase in live weight, several hundred animals, including oxen, sheep, and pigs, were subjected to experiment. In these researches, selected lots of animals were supplied, for weeks or months, with weighed quantities of food of known composition, as determined by

analysis, and especially adapted to the particular point under investigation. The animals were weighed at the beginning, at intervals during the progress, and at the close of the experiment.

The composition of the manure, produced from a given amount and quality of food consumed by oxen, sheep, and pigs, was determined in a large number of cases by analyzing average samples of the food, and then making an analysis of the solid and liquid excretions of the animals. In these experiments the oxen were fed in boxes, in which the manure was preserved with litter of known composition. After feeding for from five to nine weeks, the total manure produced was carefully mixed, weighed, sampled, and analyzed. By this method the solid and the liquid excreta were not separately examined. With sheep no litter was used, the animals, in lots of five, being fed on a slatted platform, with an inclined floor of sheet-zinc below it, so that the urine was drained into carboys containing acid, while the solid excretions were separately removed several times a day, and preserved for analysis. The constituents determined in the food and in the manure in the experiments with oxen and sheep were dry matter, mineral constituents, and nitrogen, and in some cases woody fibre. As an illustration of some of the difficulties that must be overcome in making exact investigations of this kind, a more particular description of some of the devices resorted to will be of interest. "In the case of pigs, individual male animals were experimented upon, each for periods of three, five, or ten days only. Each animal was kept in a frame, which prevented it from turning around, and having a zinc bottom, with an outlet for the liquid to run into a bottle, and it was watched night and day, and the voidings carefully collected as soon as passed, which could easily be done, as the animal never passed either fæces or urine without getting up, and in getting up he rang a bell and so attracted the notice of the attendant. The constituents determined were, in the food and fæces, dry matter, ash, and nitrogen, and in the urine dry matter, ash, nitrogen, and urea."

The amount and relative proportion of the different organs and parts of the body were determined in two hundred and forty-nine sheep, fifty-nine pigs, two calves, two heifers, and

fourteen bullocks. As the object of this investigation was to obtain average data as to the proportions of the valuable carcass parts, and the less valuable offal parts, in animals in different conditions as to fatness, a variety of animals were examined. The fifty-nine pigs were moderately fattened on a variety of fattening foods.

The percentage weights of the different parts of the body of the three classes of animals, and of the sheep in the store, the fat, and the very fat condition, are given in the following condensed table from Dr. Lawes's lecture before the Royal Dublin Society:

PARTS OF THE BODY.	Average of 16 oxen.	Average of 249 sheep.	Average of 59 pigs.	Average of 5 store sheep.	Average of 100 fat sheep.	Average of 45 very fat sheep.
Stomachs and contents	11.6	7.5	1.3	9.1	7.0	5.6
Intestines and contents	2.7	3.6	6.2	5.3	3 8	2.8
	14.3	11.1	7.5	14.4	10.8	8.4
Internal loose fat	4.6	6.9	1.6	4.5	6.0	7.5
Heart, aorta, lungs, windpipe, liver and gall-bladder, with contents, spleen, pancreas, and blood	7.0	7.3	6.6	8.4	7.7	6.5
Other offal parts	13.0	15.0	1.0	17.9	16.1	13.1
Total offal parts	38.9	40.3	16.7	45.2	40.6	35.5
Carcass	59.8	59.2	82.6	53.4	58.7	64.1
Loss by evaporation, etc	1.8	0.5	0.7	1.4	0.7	0.4
Total	100.0	100.0	100.0	100.0	100.0	100.0

It will be seen that the stomach and contents make up 11.6 per cent. of the live weight of the oxen, 7.5 per cent. of the live weight of the sheep, and but 1.3 per cent. of the live weight of the pigs, unless we include head and legs of pigs, while the intestines and contents rank in the inverse order, giving the highest percentage in pigs and the least with the oxen. If the stomachs and intestines are taken together, we find the highest percentage in the oxen, and the least percentage in the pigs. These figures correspond very closely to the relative amount of work required in the digestion of the food of the different animals, which is coarse and more bulky in the case of the oxen,

and comparatively concentrated and of higher nutritive value in the case of the pigs. The greater relative development of the intestines in pigs has a probable relation to the more complete assimilation of the food of these animals. With sheep there was a rapid decrease in the percentage of offal parts as the animals fattened, while the percentage of carcass increased from 53.4 in the store condition to 64.1 in the very fat condition. There was, however, an actual increase in the offal parts from the store to the very fat condition in the proportion of one to one and three quarters, but the carcass parts made a greater actual increase, one pound in the store condition being raised to two and one half pounds in the very fat condition.

The most satisfactory data relating to this subject that have ever been published will be found in the results of the numerous analyses of the entire bodies and parts of animals, in different conditions as to fatness, that have been conducted at Rothamsted. Determinations were made of the fat, nitrogenous substance, and mineral matter of the entire body, and of certain separated parts, of ten animals,—a fat calf, nine weeks old; a half fat ox, and a moderately fat ox; five sheep of different ages and conditions; a fat pig and a store pig. The pigs were of the same litter, and when selected were as nearly as possible alike, one weighing one hundred pounds, and the other one hundred and three pounds. "One was slaughtered at once, and its contents of nitrogenous substance, fat, mineral matter, etc., accurately determined. The other was fed on a mixture consisting of bean-meal, lentil-meal, and bran, each one part, and barley-meal three parts, given *ad libitum*, but accurately weighed, for a period of ten weeks, when it had nearly doubled its weight. The animal was then slaughtered, and analyzed as the other had been. The composition of the food was also determined by analysis."

According to the generally accepted theory of nutrition at the time the Rothamsted feeding experiments were planned, the constituents of foods were divided into two leading groups, each of which was assumed to serve a special purpose in the system. It was believed that the nitrogenous constituents were the only nutritive elements, and that the carbonaceous constituents (including the fat, starch, etc.) served as fuel, which was burned

in the system to keep up the animal heat. In the published analyses of animals and of foods at Rothamsted, this distinction was recognized, and the results are given in terms of these groups of constituents. A summary of the results of the analyses of the ten animals described above is given in the following table, in percentage values of groups of constituents, in the carcass and in the total offal parts:

ANIMALS.	Mineral matter (ash).		Nitrogenous substance (dry).		Fat (dry).		Total dry substance.		Water.	
	In carcass.	In offal.	In carcass.	In offal.	In carcass.	In offal.	In carcass.	In offal.	In carcass.	In offal.
Fat calf	4.48	3.41	16.6	17.1	16.6	14.6	37.7	35.1	62.3	64.9
Half-fat ox	5.56	4.05	17.8	20.6	22.6	15.7	46.0	40.4	54.0	59.6
Fat ox	4.56	3.40	15.0	17.5	34.8	26.3	54.4	47.2	45.6	52.8
Fat lamb	3.63	2.45	10.9	18.9	36.9	20.1	51.4	41.5	48.6	58.5
Store sheep	4.36	2.19	14.5	18.0	23.8	16.1	42.7	36.3	57.3	63.7
Half-fat old sheep	4.13	2.72	14.9	17.7	31.3	18.5	50.3	38.9	49.7	61.1
Fat sheep	3.45	2.32	11.5	16.1	45.4	26.4	60.3	44.8	39.7	55.2
Extra fat sheep	2.77	3.64	9.1	16.8	55.1	34.5	67.0	54 9	33.0	45.1
Store pig	2.57	3.07	14.0	14.0	28 1	15.0	44.7	32.1	55.3	67.9
Fat pig	1.40	2.97	10.5	14.8	49.5	22.8	61 4	40.6	38.6	59.4
Means of all	3.69	3.02	13.5	17.2	34.4	21 0	51.6	41.2	48.4	58.8

This table furnishes some important data for an intelligible discussion of the economics of nutrition with reference to human dietaries, but there are many points of interest presented in the details of the analyses of these animals that cannot be embraced in such a tabular abstract. In the carcass of the fat calf, it will be noticed, the percentage of nitrogenous substance and of fat is the same, while in the other animals the fat is largely in excess, even in those in store condition. There is likewise a larger percentage of nitrogenous substance in the offal parts than in the carcass in all cases [especially in that of extra fat sheep.—SEC.]. It was also found that "the fat of the bones bears but a small proportion to that of the whole carcass, while, of the whole of the nitrogen of the carcasses, perhaps not

less than one fifth will be in the bones. * * * As the animal matures, the mineral, the nitrogenous, and the fatty matters all increase in actual amount; but the percentage of both mineral matter and nitrogenous substance decreases, while that of the fat increases so as to much more than compensate for the decrease in that of the other solid matters. The result is that there is an increase in the percentage of total dry substance." The young animals, as the lamb and calf, had a larger proportion of water in the carcass than other animals in the same condition, and there was a larger proportion of bones in the carcass of the calf than in the carcass of the other animals.

In estimating the composition of the increase in live weight of fattening animals, it was assumed that the composition of the original weight,—that is, the weight at the beginning of the feeding period,—was the same as in the "store" or "half-fat" animals that had been analyzed, and that the composition of the animal at the close of the feeding period was the same as that of the "fat" or the "very fat" animal that had been analyzed. The estimated average percentage of mineral matters, nitrogenous substance, fat, and total dry substance, in the increase of these animals, is given in the following table:

ANIMALS.	Mineral matter (ash).	Dry nitrogenous substance.	Fat.	Total dry substance.
98 oxen—average.....	1.47	7.69	66.2	75.4
349 sheep—average.....	2.34	7.13	70.4	79.9
80 pigs—average.....	0.06	6.44	71.5	78.0
The analyzed fat pig.....	0.53	7.76	63.1	71.4
Means.....	1.10	7.26	67.8	76.2

We may now consider the relations of the constituents of the food to the constituents stored up in the increase. In all of the feeding experiments it was found that the amount of food consumed by a given live weight of the animal, within a given time, and also the increase in live weight obtained from it, depended more upon the non-nitrogenous constituents, or even on the total dry substance, than upon the nitrogenous constituents, which

had been generally assumed to be the true measure of nutritive value. In experiments with animals expending their energies in the form of work, the same demand for the non-nitrogenous constituents of the food was observed as in the case of fattening animals. A certain moderate amount of nitrogenous substances was evidently needed in the food, but any increase beyond this required quantity had no influence upon the returns obtained for food consumed, either in the form of muscular force in working animals, or in increase in live weight in those that were fattened, or even on the amount of nitrogen contained in such increase. The nitrogen discharged in the urine, in the form of urea, was found to have no relation to the activity of the muscles, but it was directly increased by an increment of nitrogenous materials in the food. The age and habits of the animals themselves, when growing or fattening, seemed, however, to determine to some extent the proportions of nitrogenous materials in the stored-up increase.

The average results show that the oxen supplied liberally with food of good quality, containing a moderate proportion of grain or other concentrated food, would consume at the rate of from twelve to thirteen pounds of dry substance per week for each hundred pounds of their weight, and that one pound of increase in live weight would be returned for it. Sheep of several different breeds consumed, on the average, about fifteen or sixteen pounds of dry substance of slightly better food per week for each hundred pounds of live weight, and returned about one pound of increase in weight for each nine pounds of dry substance in their food. Pigs, with food composed largely of grain, consumed from twenty-six to thirty pounds of dry substance per week for each hundred pounds of live weight, and yielded one pound of increase in weight for each four or five pounds of dry substance in their food. Oxen, therefore, consume more dry substance of food in proportion to their weight than sheep, and sheep consume more than pigs, while, in return for feed consumed, pigs yield more than sheep, and sheep gave better results than oxen. It must be remembered in this connection, as has already been pointed out, that the food of oxen contained more woody fibre, while that of the pigs was comparatively concentrated and digestible, and therefore of better quality. With sheep of differ-

ent breeds it was found that, under the same conditions as to age and fatness, the food consumed was in proportion to their live weight. The relative value of the larger and smaller breeds seems, therefore, to depend, to a great extent at least, upon their habits and hardiness, and their adaptation to the conditions of the locality in which they are placed.

The results of the experiments relating to the use and ultimate disposition of the food consumed by animals when fattened under average conditions, as to feed and increase, are given in the following table:

ANIMALS.	Each 100 pounds of dry substance in the food consumed was disposed of as follows:		
	Stored up as increase.	In manure.	Used in internal work of the system, and not accounted for in manure or increase.
Oxen	6.2	36.5	57.3
Sheep	8.0	31.9	60.1
Pigs	17.6	16.7	65 7

From an agricultural stand-point, the proportions of food-constituents stored up as increase, and voided as manure, are of the first importance, as these are the two factors that determine the economy of feeding. The expenditure of energy in the system, from the nitrogenous constituents of the food, is not therefore included in the last colnmn, as all of the nitrogen of the food that is not stored up as increase is finally excreted in the urine. The first and second columns of the table therefore include the nitrogenous and the mineral substances of the food, and any energy that may have been expended as a result of their metamorphoses is not represented in the table.

When the facts are examined from a different stand-point, the relations of the increase to work of the system will be more clearly seen, as in the following table, which gives the results obtained from a given live weight of the animals in a given time:

ANIMALS.	For each 100 pounds of live weight, per week.				
	Stored as increase.	Dry substance.			
		Consumed in food.	Recovered in manure.	Used in internal work of the system, and not accounted for in manure and increase.	Used in internal work for each one pound of stored increase.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Oxen.....	1.13	12.5	4.56	7.16	6.34
Sheep	1.76	16.0	5.10	9.62	5 47
Pigs.....	6 43	27.0	4.51	17.74	2.76

The oxen make in increase but little more than one per cent. of their weight per week, the sheep make one and three fourths per cent., and the pigs nearly six and one half per cent. of their weight per week. Nearly the same amount of dry substance of the food appears in the manure of the different animals per week for each hundred pounds of their live weight. In proportion to their weight, the pigs consume more food, and a larger amount of food-constituents is actually used in work of the system, but, from the greater rate of increase, the work required to produce a pound of increase is less than one half of that required in oxen.

The percentage of each group of food-constituents stored up as increase, and voided in the manure, is given in the next table:

CONSTITUENTS OF FOOD.	Each 100 pounds of food-constituents consumed was disposed of as follows:					
	Stored up in increase.			Voided in manure.		
	Oxen.	Sheep.	Pigs.	Oxen.	Sheep.	Pigs.
Nitrogenous substance..	4.1	4.2	13.5	95.9	95.8	86.5
Non-nitrogenous sub'ce.	7.2	9.4	18.5	14.1	8.9	4.1
Mineral matters.....	1.9	3.1	7.3	98.0	97.0	92.7

The nitrogenous substance and mineral matters, as will be seen, are all accounted for in the stored-up increase and the manure, but there remains from 77.4 to 81.7 per cent. of the non-nitrogenous substances that cannot be found in the increase of the body, or in the residual manurial excretions, as they have been used in internal work, and excreted in the process of respiration.

Sheep store up as increase a larger proportion of all the food-constituents than oxen, and pigs store up a much larger proportion than sheep. The percentage of nitrogenous constituents stored up as increase, or voided as manure, will vary widely with different foods.

Among the many important results obtained in the experiments at Rothamsted, the data furnished for estimating the relative value of barnyard manures are of particular interest. The essential constituents of barnyard manure, or those having a commercial value, are nitrogen, potash, and phosphoric acid, which are of course derived from the feed consumed by the animals making the manure. The composition of the food being known, the percentage of its several constituents that are voided in the manure may be estimated from the data obtained in these experiments, so that the relative value of the manure produced from different articles of food can be determined with sufficient accuracy for all practical purposes. From the results of the Rothamsted feeding experiments, we cannot avoid the conclusion that the cereal grains and the highly nitrogenous linseed and cotton-seed cakes have essentially the same value as fattening foods, and that there is but little, if any, difference in the feeding value of timothy and clover hay. When the production of manure is concerned, however, the clover has a much higher value than timothy, and the linseed and cotton-seed cakes are worth very much more than the cereal grains.

From the facts already presented, it appears that a large proportion of the increase of fattening animals, in many cases more than two thirds, is fat. It was formerly supposed that the fat of animals was derived from the fatty materials in the food, but this source was found to be entirely inadequate. The non-nitrogenous constituents of the food,—the carbo-hydrates,—were then quite naturally looked upon as the source from which the

fat was elaborated; but afterward Professors Voit and Pettenkofer insisted that the fat of animals was almost exclusively formed from the nitrogenous constituents of the food. In experiments with pigs, which are evidently the most suitable animals for experiments relating to the formation of fat, Drs. Lawes and Gilbert conclusively show that, with foods in which the ratio of the nitrogenous to the non-nitrogenous constituents was a suitable one for fattening purposes, as in Indian corn and barley, a large proportion of the fat in the stored-up increase must have been produced at the expense of the non-nitrogenous constituents. There was also evidence that the nitrogenous constituents of the food, when in excess, might replace the carbo-hydrates, to some extent, in the formation of fat.

The analysis of the entire bodies and parts of the ten animals made at Rothamsted furnish some interesting data in regard to the composition of the animal food consumed by man. It has been generally assumed that the effect of animal food in human dietaries is to increase the proportion of the nitrogenous constituents. From the results of these analyses, however, we can not escape the conclusion that the animal elements of a diet, as a whole, increase the proportions of the carbo-hydrates or non-nitrogenous constituents. It appears that two thirds of the nitrogen of the entire body, of the calf and bullocks, was found in the carcass, and of this twelve parts were in the bones, leaving fifty-four per cent. of the whole nitrogen of the body in the soft parts of the carcass. Of the thirty-three per cent. of the nitrogen of the entire body in the offal parts, it was estimated that in the calf seven to eight parts, and in the oxen four to five parts, would be consumed as human food. Of the total fat of the body, about seventy per cent. in the calf, and rather more than seventy-five per cent. in the oxen, were found in the carcass. Of the fat contained in the offal parts, it was estimated that five sixths in the calf and one fifth in the oxen would be consumed as human food. The percentage of the total nitrogenous and total non-nitrogenous constituents of animals, included in the food of man, has been tabulated by Drs. Lawes and Gilbert as follows:

ANIMALS.	Per cent. consumed as human food.	
	Of the total nitrogenous compounds of the body.	Of the total fat of the body.
Calves	60	95
Oxen	60	80
Lambs	50	95
Sheep	50	75
Pigs	78	90

According to this estimate, "there would be, in the fat calf analyzed, 1½ times, in the fat ox, 2¾ times, in the fat lamb, fat sheep, and fat pig, nearly 4½ times, and in the very fat sheep, 6¼ times as much dry fat as dry nitrogenous constituents" in the parts of the animals consumed as human food. As one part of fat is equivalent to two and one half parts of starch, as a source of potential energy, which must be taken as the measure of nutritive value, it will be necessary to estimate the fat in its equivalent as starch, in making a comparison of vegetable and animal foods with reference to their nutritive value, and the relative ratio of their nitrogenous and non-nitrogenous constituents. On this basis the results of the Rothamsted analyses have been tabulated as follows:

RATIOS.

DESCRIPTION OF ANIMALS.	Proportion of dry fat to 1 of dry nitrogenous compounds.		Proportion of starch-equivalent of fat to 1 of dry nitrogenous compounds.	
	In carcasses, including bones.	In estimated consumed portions of the animals.	In carcasses, including bones.	In estimated consumed portions of the animals.
Store, lean, and half-fat animals:				
Store sheep	1.64	.....	4 09	.....
Store pig	2.01	.....	5.02	.....
Half-fat ox	1.27	1.53	3.17	3.83
Half-fat old sheep	2.11	2.51	5.27	6.28

RATIOS—*continued.*

Fat and very fat animals:				
Fat calf	1.00	1.54	2.49	3.85
Fat ox	2.31	2.76	5.78	6.91
Fat lamb	3.39	4.40	8.49	11.01
Fat sheep	3.96	4.37	9.89	10.93
Very fat sheep	6.07	6.28	15.18	15.69
Fat pig	4.71	4.48	11.77	11.20
Means:				
Store and half-fat animals.	1.76	2.02	4.39	5.05
Fat and very fat animals	3.57	3.97	8.93	9.93
Of the ten animals analyzed	2.85	3.48	7.11	8.71

For comparison with these ratios of the nutritive constituents of animal foods, wheat-flour bread was selected as one of the most important of the representative articles of vegetable food. The fat in the bread itself, estimated at one per cent., which is probably above the average, was reckoned in its equivalent of starch, and the ratio of nitrogenous and non-nitrogenous constituents was then found to be 1 to 6.8. Of the animals fattened for the butcher's use, the fat calf, only, gives a smaller proportion of non-nitrogenous constituents than the bread; the fat ox has nearly the same, and the other animals very much more. The averages also show that beef, mutton, and pork, on the whole, are not deficient in carbo-hydrates or non-nitrogenous nutritive constituents. After a full discussion of the subject, Drs. Lawes and Gilbert come to the conclusion that the great advantage of a mixed bread and meat diet over one of bread alone, does not depend on the nitrogenous substance, but rather in substituting fat for a portion of the starch of vegetables. From the greater value of fat as a source of energy, and the general advantages of a variety of nutritive elements in the composition of a diet, this view of the influence of animal food seems to be well founded.

It is perhaps worthy of notice that nitrogen was the prominent object of interest in the Rothamsted field experiments, while the carbo-hydrates or non-nitrogenous constituents of the

food seemed to be the ruling elements in the feeding experiments. Is this apparent contrast in the materials required as leading factors in the economy of plants and animals a mere coincidence arising from the methods of investigation, or does it represent one of the correlations of organic life concerned in the conservation of energy? The mineral and nitrogenous constituents of plants are taken up by their roots from the soil, which is almost, if not quite, the exclusive source of these elements of plant-growth, while all of the carbon is elaborated by the leaves from the supplies in the atmosphere. The mineral and nitrogenous constituents of the food of animals, on the other hand, are all discharged from the system after performing their functions, in the liquid and solid excretions, and thus find their way to the soil, where they can be appropriated as plant-food; while a large proportion of the carbo-hydrates are exhaled in respiration as carbonic acid, the atmospheric food of plants. By this constant circulation in their appropriate channels, the conservation of the nutrient elements of both plants and animals is fully maintained.

THE UTILITY OF BIRDS IN AGRICULTURE.*

BY PROF. W. A. STEARNS, AMHERST, MASS.

I shall not hope to be able to add much really new material to the subject in question, but should I glean from our previous knowledge a few perhaps hitherto neglected facts, and present them in a pleasing manner and in a new light, my labor will not have been entirely lost.

Though I am sensible that what I shall say could have been contained in half as many words, better chosen, perhaps, you must take the good-will for the deed.

PART I.

CLASSIFICATION.

As a preliminary to the main part of my discourse, I hope I may be excused for first presenting a little dry detail as to the natural characteristics of this class of the animal kingdom, and their arrangement in classification according to the latest and most approved authorities. It is a subject about which but little need be said in such a place as this, chiefly for want of time; but that little seems required, more for the edification of those who as yet are unacquainted with the "*new system*," if there be any such, than because it is required here, while it will form an apology for an introduction to the body matter of the pages that shall follow, and perhaps answer such a purpose equally well.

The classification of birds most familiar to the majority is undoubtedly that of Illigers and Vigors, as modified from and added to that of Linnæus, the father of this as of other scientific classification, and consists of seven orders, as follows:

*This paper was read by the author at a meeting of the Connecticut Board of Agriculture. It will appear in the volume for 1883, and is published in this Report by permission of the author.

Raptores, or Birds of Prey.
Insessores, or Perching Birds.
Scansores, or Climbers.
Rasores, or Scratchers.
Cursores, or Runners.
Grallatores, or Waders.
Natatores, or Swimmers.

These seven orders have been in general acceptation for the last fifty years, and it is only until recently that the great advance made in ornithology has reduced the whole sub-kingdom of birds to an almost complete definition. It is needless to mention particularly the names of Baird, Brewer, Ridgeway, Coues, and others, as they are too well known to need it, but a few words will explain the latest additions and revisions of this most important field, as recommended chiefly by these gentlemen. As formerly the Raptores, or Birds of Prey, were placed first, so now perfectness of structure and superiority of intelligence have caused the carrion crow and robber eagle to "step down and out," so to speak, while the well-known robin, the head of the thrush family, assumes the head of the tribe, and is soon followed by the more intelligent of the Insessores. As the group now stands, we have the following three classes, and eleven orders:

Class 1st. (*Aves Aereæ.*)—Birds spending most of their time above the earth, among the branches of the trees—in the air, so to speak—comprising,—

Order 1. Passares, or Perchers.
" 2. Picariæ, or Woodpecker-like birds.
" 3. Psittaci, or Parrots.
" 4. Raptores, or Birds of Prey.
" 5. Columbæ, or Pigeon-like birds.

Class 2d (*Aves Terrestres.*)—Birds spending most or all of their time on the earth, seldom lighting or remaining on trees,—

Order 6. Gallinæ, or Runners, Scratchers, and the like.
" 7. Grallatores, or Waders.

Class 3d (*Aves Aquaticæ.*)—Birds that swim in the water,—

Order 8. Lamellirostres, Ducks, etc.

ORDER 9. Steganopodes, Pelicans, etc.
" 10. Longipennes, Gulls, etc.
" 11. Pygopodes, Diving Birds.

We cannot stop now to define all these orders, but will simply say, that the system of which these eleven orders form the basis, especially of North American birds, though there are very few changes to be made to have the system answer for birds everywhere throughout the world, proves one of the most simple and most expressive of the real position held by this family in nature of any yet devised. It is only those extreme ornithologists who strive to render difficult that which they should render easy, whose innovations we have to dread. The greatest change, you will perceive, has been made in the second order, which the new system has called the Picariæ, or Picarine, or woodpecker-like birds, but which the old system has named respectively *Strisores*, or those birds whose third toe is capable of being retracted, so that the bird can stand with two toes in front and two behind, or three toes in front and one behind, at pleasure; also, *Scansores*, or climbers; also, *Zygodactyli*, or birds having their claws arranged two in front and two behind, and containing the woodpeckers alone. Now it was found that the woodpeckers differed in themselves in this respect, so that any order which answered for part really answered for all, so that all those birds whose structure is really so near alike, and whose definition really presented, formerly, so many puzzling features to the ornithologist, are now classed together and put in their true place, *after* the Perching birds, and *before* the Parrots, which connect them with the Raptores;—thus the succession of orders is complete, and perfectly natural. Another seemingly great, but, in reality, simple, change, is the making of four out of one former order; thus the original Natatores becomes Lamellirostres, or Ducks, etc., Steganopodes, or Pelicans, etc., Longipennes, or Gulls, etc., and Pygopodes, or Diving birds. Each of these appears separate and distinct enough to form an order by itself, and especially when are taken into consideration the birds which are placed in them from their abodes in other countries. But this matter will appear better in print than it does spoken here; so let us proceed at once, with this preliminary view of the subject, to the main body of our discussion.

PART II.

THE UTILITY OF BIRDS IN AGRICULTURE.

The utility of birds in agriculture is a subject about which very little has been written, as it is one about which comparatively little is known. The fact is, that while our standard ornithologists, such as Audubon, Wilson, Nuttall, and others, who had time for such investigations, were unable to incorporate them into their works from the necessity of expense of publication, our later authors have been unable to spare the time for such occupation, though abundantly assured of surety of publication. It is true that a very few authors have mentioned a very few facts connected with the relation between birds and agriculture, but as yet little practical good has resulted to the farmer from them. Although it would be strange if I should be able to add much real new material to the subject as presented to-night, I shall strive to collect from the various sources somewhat of the material already before the public, and present it to you in as attractive and practical a light as I may be able.

It is only within recent years that it has been discovered that birds fulfilled a useful, and often most valuable, part in the economy of nature. What few facts we do know regarding the matter have been obtained more through the direct experience of those who have stumbled on the facts they relate, than those who have made any special study of the matter. One great difficulty has been, that people looked too far and studied too deeply for facts which were right before them. For instance, people are well acquainted with the fact that hawks, becoming bold, pounce down upon and carry off chickens from the henyards and eat them. How many are acquainted with the fact that, in hard winters, when pressed for food, crows do this likewise? But what does this signify? Simply that the crow regulates its food from necessity, and not from choice. Now carry this fact into operation in the spring, into the corn-field. Do you suppose that the crow, being hungry, and dropping into a field of corn wherein is abundance to satisfy his desires, stops, as many affirm, to pick out only those kernels which are affected with mildew, larva, or weevil? Does he instinctively know what corns, when three or four inches beneath the ground, are

thus affected or not? Not a bit of it. To him, a strictly grain-feeding and not an insect-eating bird, the *necessity* takes the place of the choice. He is hungry: the means of satisfying his hunger present themselves. He naturally drops down into the first corn-field he sees, calls all his neighbors to the feast, and then roots up and swallows the kernels, until he can hold no more. Such, so far as known, are the facts of the case. Do they look reasonable? Pages and pages of papers and magazines have been used in disputes as to whether or not the crow was beneficial, or injurious, to agriculture. To me, at least, in view of the above generalized statement, borne out by facts as shown, the answer is plain enough.

Let us take another example: On the other hand, the robin is a bird which, like the crow, has had pages upon pages written upon the question as to whether it was beneficial, or injurious, to the agriculturist and farmer. It is certainly true that in the summer season the robin raids upon the fruits of the garden, both those which grow upon the vines and small plants bearing them, and also upon the trees, and fills himself with the richest and most luscious that he can find. Not only does he do this, but brings his whole family with him to partake of it also. Now the question has been raised here, too, as I have said, Is the robin beneficial, or injurious, to the farmer? Of course, in answering the question, we must look fairly at both sides, and then find the difference between them, the side upon which this difference stands outweighing the other for good or evil. We will suppose that, in the fruit season, the robins appear in large numbers, and literally besiege the trees and plants containing fruit of some farmer. If, in consequence, the farmer loses everything, then the crop is a failure, as it would be in a drouth or bad year otherwise. Now, supposing he loses part, say two fifths, or even one half, he yet reaps an average crop,—since the insects might have spoiled as much as this,—and thus *gives* to the *birds* what he would otherwise *lose* by the *insects* or some other means. Let us see if he gets any return for this expenditure. As the crow is eminently a grain-loving and grain-feeding bird, so the robin is an insect-eating and insect-feeding bird: being such, it prefers insects in their larval, pupal, and adult stage to any other food. This statement has been proven time

and again. Experiments have been made and observations recorded that prove the truth of the following deduction, from the pen of a well-known ornithological writer. He says,—"The prejudice which some persons entertain against the robin is unreasonable. Few persons have any idea of the enormous, the literally incalculable, number of insects that robins eat every year. It has been found, by careful and accurate observations, that a young robin in the nest requires a daily supply of animal food equivalent to considerably more than its own weight! When we remember that some millions of pairs of robins raise five or six young ones, once, twice, or even three times a year, it will be seen that the resulting destruction of insects is, as I have said, simply incalculable." This same writer adds, furthermore,—"I have no doubt that the services of these birds, during the time they are engaged in rearing their young alone, would entitle them to protection, were the parents themselves to feed exclusively upon garden fruits for the whole period. But at this time the diet of the old birds is very largely of an animal nature; nor is this the only season during which the destruction of insects goes on. Upon the first arrival of the main body of the birds, early in the spring, long before any fruits are ripe, they throw themselves into newly-plowed fields, and scatter over meadows, lawns, and parks, in eager search for the *worms* and *grubs* that, later in the season, would prove invincible to the agriculturist, were not their ravages thus stayed in advance by the friendly army of robins."

Now try the experiment yourselves. Watch the development of the young birds, note the kinds of food their mother brings them, and even dissect the stomachs of a few of these young birds, and examine carefully, with the lens, their contents. Facts are not worth presenting separated from their proofs. Try the case yourselves; be your own judge and jury; pronounce your own verdict. I will venture to say, that, in the face of the nature of the bird and its habits, the nature of its required food, and the nature of verified observations made time and again, you cannot come out far from a correct result. It does no harm to put scarecrows and the like in your trees and garden to drive off the birds, but hardly pays to deceive yourselves in that your killing them will be a material benefit. But take another point

of view: The robin is eminently a *game* bird, and makes the most delicate and delicious eating known, almost. If, therefore, you beg the question, kill a mess for a savory pot-pie at such time as when they are in the height of their plunder, you accomplish your purpose, and can say conscientiously that you have not violated any law for the good of the community. We have taken two birds, then, the crow and the robin, and settled, by appealing to "the nature of the case," pretty definitely the position of each in the economy of nature, as well as their utility in agriculture, taking each from the same stand-point, that we might show how an examination of this kind is to be made.

It may be stated, as a pretty correct rule, that wherever the large grain fields of our countries are found growing, there the swallows are abundant. This, though true as a whole, is especially true of the republican, commonly called the cliff or eave swallow, and of the barn swallow. The bank swallow comes in for a share of this, also. It is well known that the summer range of these birds includes nearly all the central portion and the great grain-growing regions of the West. They are all more or less migratory, and spend their winters in Florida and the southern portions of the Gulf states. We do not here include the chimney swallow, more correctly known as the chimney swift, since it flies in the upper strata of the air, while the three species above mentioned fly low, and near the ground. The question which now arises, especially in our New England States, is, Does not the swallow (these species above referred to) do more harm as a pest about the houses and barns, where it clusters beneath the eaves, and builds its nest in every possible corner, than it does good as an insect-catcher? In many of our villages, as you well know, the houses and barns of the people are fairly overrun with the eave and barn swallow. Hundreds of nests have been counted in the small area of the eaves of a single barn, with as many more, perhaps, on the other side, without counting those building inside the building. But, as pestiferous as they are with their chatterings, and the annoyance they give the farmer in various other ways, let us look at the other side. The grain fields, especially of wheat and corn, are attacked in the summer by several species of small insects, like the midges and several similar species, that in the course of

the season destroy millions of dollars' worth of grain, while often whole fields are nearly ruined by their ravages. When escaping from the pupa-case, these insects fly over the tops of the stalks, and from one part of the field to another. This time of the year happens to be about the same as that at which the swallow seeks an extra amount of food for itself and its young. Strange to say, the swallow becomes the natural enemy of these insects, and pursues them with unremitting vigilance. Supposing that a single pair of birds have a nestful of five young, a full nest complement,—though six are sometimes raised, rarely four, or less: suppose that each young bird receives thirty visits an hour, at each of which it receives two or three insects, since the old bird catches several in quick succession, and stows them away in the sides and corners of its mouth: we will also suppose that both birds alternate in their visits, and that this is kept up from sunlight to sunset, or a day of say fifteen hours for the period of being cared for, or say twenty-one days, usually the time required for a brood to begin to feed themselves: let us look at the result. One single nesting of a single pair of birds will have consumed the enormous amount of nearly 500,000 insects in this short time. As I have often known of several hundred nests being attached to the buildings of a single farmer, while several farmers often live quite close together, it is safe to say that the benefit these birds do is simply incalculable.

Let us look still further: The swallows and the bluebirds fight for the boxes which it used to be a great fashion to put up in various places for their reception. Formerly the swallows retained undisputed possession. Latterly the insect-enemies to all the fruit and garden trees and plants began to increase; the swallows, never staying near the houses to catch their food, were beaten, and driven off to the barns where they belong, and whence they continue their raids upon the grain-fields, while their conquerors took possession of the boxes, built, and reared their young, getting tamer and more abundant each year, until now they build wherever they can find a suitable location, be it in the holes of the corner-pieces of the house piazzas themselves, even. They at once attack the insects about the lawn, and do for the fruit- and shade-trees what the swallows do for the field, *but each* in his proper place. Still again: The purple

martins, for a time, contended with the bluebirds for the boxes. The martins are an indolent set, and, though insect-eating birds, *fly high* to catch their food. So, as they were unable to take the place of the bluebirds in Nature's economy, they were whipped and sent off to seek for themselves other regions, where they belonged. The result is, that in New England, to-day, the martin is comparatively a rare bird, except in one or two especial localities where they are especially protected by the dwellers there. Do I wrongly place these illustrations as a fair sample of what I mean by the economy of birds in agriculture? But I have only given a most common and general example, and one that will be readily understood,— in fact, a most simple one. Let us take another, and one that will combine, in a measure, the answer to a previous question. Formerly, and even to a great extent latterly, the king-bird, or bee martin, as it is better known to farmers keeping these latter insects for the sake of their honey, was voted a terror to all bee-keepers, and a nuisance to the agriculturist generally. But, strange to say, it was found that the immense numbers of other insects that it destroyed more than counterbalanced the evil it did when attacking the honey-bee. But this is not all: for a long time it was found impossible to prevent the ravages of various species of birds upon fruit and fruit-trees, during that portion of the summer when the delicious article most abounded. By a strange coincidence, I made a practical test of a most important point on this subject some years ago. It was and is well known that the king-bird, the most fearless fighter of the feathered tribe, attacking with violence crows, hawks, and, in fact, any bird that interferes or intrudes in the domestic arrangements of its helpmate, was particularly active in preservation of self and family during the season of nidification and incubation. Several years ago I found that one of these birds built its nest and raised its family in the corner of an eave-spout at the front end of our house. Not five rods from this place stood a cherry-tree, of the variety I believe you call the ox-hearts. Here for years we had struggled to see who would get a mess of this most delicious tasting fruit. For an equal amount of time it had been "nip and tuck," so to speak, between the birds and ourselves. We had tried red flags in the tree, and the birds minded them not a straw; we had put

scare-crows and old hats in among the branches, and the birds lighted upon them and mocked at our efforts; we had tried shooting, and though a few birds were killed, ten came to the funeral of each,—and many of the fine limbs of the tree were so riddled with shot that they died during the following autumn and spring. What to do we did not know.

In our dilemma we suddenly, one season, found the tree clear of robbers, and in surprise and delighted wonderment we feasted off the delicious fruit for the whole of that season. The next season was the same. No apparent cause could be ascertained for this reign of quiet, for a considerable while. It was at last discovered that while our friend, the king-bird, continued its nest in the eave-spout, no other bird was allowed nearer than a radius of some twenty or more rods of the tree. This took in another similar tree upon the opposite side of the walk. Thus had been raised to us a natural protector to our fruit. We cultivated the acquaintance of our favorite, threw cotton and pieces of string where he would find them, and were delighted to find that he took kindly to our suggestions, and appeared to become domesticated. Finally, one year, lately, he disappeared, whether killed or no by some mischievous boy or unscientific sportsman, I do not know. To our horror the birds returned, and our berries were eaten up.

Still another example: The orioles, when the pease are ripening, will alight upon the vines, eat the pease by the podful, and then actually amuse themselves by slitting open the pods and emptying their contents, when they cannot possibly eat them themselves, apparently from mere wantonness. These same king-birds, building in an apple-tree near the pea-vines, waged such a war with the orioles, that for one year at least we were not troubled at all with the loss of our pease. Now it has been abundantly proven by others besides myself, that the king-bird, if suitably baited with scraps of cotton, strings, and other loose material suitable to complete a nest, will soon accustom itself to building in and about the orchards, gardens, and even the houses of our farmers, and thus protect thousands of dollars' worth of vegetables and fruits. It is strictly an insectivorous bird, and will not destroy, on the whole, that which conduces to the interests of the farmer. I will set it down in the following state-

ment, which I am prepared to "*back up*" with abundant proof and further evidence, that the king-bird is one of the most valuable species of birds to the agriculturist, and, if properly encouraged, will save for him hundreds if not thousands of dollars' worth of provisions in a season. Legislation in regard to this bird should be of the strictest kind.

Another species, doing an immense amount of good in its own quiet way, is the yellow-billed, as also its ally, the black-billed, cuckoo. These birds build in apple- and fruit-trees. They are strictly insect-eating, while they make terrible raids upon the caterpillar that infests the trees at this season. They should be encouraged in all possible ways.

BLUE JAY.

With regard to the jay, authorities differ upon which side to place him; he undoubtedly does much to benefit the farmer indirectly, and even more or less directly; and yet he does so much direct damage, and becomes such a ruthless destroyer at certain times and at certain seasons, that it is almost absurd to class him among the friends of the agriculturist.

The blue jays persecute the hawk with unrelenting fury, whenever they find him in anything approaching to a helpless condition: for this they should receive a mark upon the good side;—yet they are just as furious towards the owls, who do little but good in their destruction of the moles and field mice that often do such immense damage to the ripening crops: for this they should receive a corresponding demerit. The blue jay, when pressed for food, will seek and devour almost anything that he can get hold of. In this he is followed by his northern friend, the Canada jay, who makes himself as familiar in northern Canada as does our species here. When the fit is upon him he visits the nests of every bird in his vicinity. It is an old trick of his to eat their eggs, and should the nest contain young birds, it makes no difference to him. Should this prove insufficient, he turns hunter himself, and then eats the entrails, and possibly the bodies also, of those birds which he has captured. It is safe to say that hundreds of beneficial birds are thus destroyed each year. On the other hand, Wilson mentions the fact that a letter from his friend, Mr. Bartram, contains the fol-

lowing remarkable passage concerning this bird. He says,— "Their chief employment during the autumnal season is foraging to supply their winter stores. In performing this necessary duty, they drop abundance of seed in their flight over fields, hedges, and by fences, where they alight to deposit them in post-holes, etc. It is remarkable," he continues to say, "what numbers of young trees rise up in fields and pastures after a wet winter and spring. These birds alone are capable, in a few years' time, to replant all the cleared land."

Undoubtedly this statement is true to a limited degree, and any one who has watched the movements of this bird at all is well aware of his propensity for dropping acorns, and perhaps other nuts, from the trees upon which they grow. But a single point further, about which I feel quite positive, though yet I may be mistaken, is the fact that, so far as my observation goes, the blue jay does *not* molest grain-fields to any great extent, though this is a matter requiring much further attention and record.

BALTIMORE ORIOLE.

Were it not that the destructiveness of the Baltimore oriole among the pea-vines in early summer is too well known and feared, this bird might be classed as among our most useful friends and benefactors. He confines himself chiefly, so far as observation proves, to a class of insects hardly reached by any other bird: I refer to the Chrysomelidæ, or leaf beetles, and the larvæ of many species of insects, inhabiting the tops of such trees as elm, oak, and apple.

His clear, shrill clarion enlivens the early morning of the mating season, and his beautiful plumage pleases the eye; yet he lights upon the pease at every available opportunity, and rips the pods from top to bottom while he eats the young pease, and soon strips the vines. At the end of the season, however, a balanced account shows the credit to be largely in his favor.

WHITE- AND RED-BELLIED NUTHATCH.

Now let us look at a different species of bird, and note the line in which his utility presents itself: I refer to the white- (as also the red-) bellied nuthatch. As to the name nuthatch, which is supposed to have been derived from the habit of the bird of

cracking nuts, there seems to be some question amongst authorities. Though the bird certainly stores away immense quantities of tender-shelled nuts, like the chestnut and others, Dr. Brewer showed conclusively that it was for the purpose of extracting the insect larvæ contained therein, rather than to feed upon the meat or kernel of the nut itself. However the case may be, strange as it may appear the white-bellied nuthatch is probably one of our best friends in the economy of nature in saving from destruction our fine forest trees, especially the oak, chestnut, elm, maple, and other rough-barked trees. It has been suggested that the bird injured the trees by tearing off large quantities of bark, and thus exposing the soft inner bark to the weather and to loss of sap: but not a bit of it. The nuthatch is eminently an insect-eating bird; it lives upon grubs and the larvæ of insects, often eating the insects themselves, as any naturalist who has dissected any number of them will admit. Beneath all these pieces of bark thus apparently ruthlessly torn off, the grub was at work, or the insect in the process of laying its eggs was concealed: the enemy was captured, and the tree saved. All day these little fellows travel up and down the trunks and branches of the forest; round and round, again and again visiting the same portions, or flying from tree to tree, as the prospect of a good meal presents itself. It rears its young in the woods, and there searches all the more patiently for food for its brood of from four to six young. Kill off the nuthatches, and our forests will suffer correspondingly. In these days, when "forest congresses" are in order, one of their first acts should be to protect the nuthatch.

BLACK-CAPPED TITMOUSE, OR CHICADEE.

Next to the nuthatch, the chicadee, perhaps, claims our attention. This is one of the most active, busy, and cheery little fellows of our woods during the summer, or our gardens during the colder parts of the year. They always associate more or less closely with the nuthatches, and, in fact, resemble them greatly in habits, though in spirits they are a miniature blue jay. Of a fine autumn afternoon I have often amused myself by lying down in the woods and noting the curiosity of these little fellows as they cautiously approach and peer at one. Be very

careful, and one will finally hop within a few inches of you, and, though watching with the appearance of perfect confidence and familiarity, the least movement of the body will send him off with a shrill dee! dee! dee! into the thicket beyond. Among themselves they fight incessantly, and have been said to kill their weak and sickly birds in the nest. They feed upon almost anything when driven by hunger, yet the direct benefit they do the forests is only estimated by the immense numbers of insect larvæ consumed during the year. Their small bill enters where that of the nuthatch cannot. In summer they feed six to eight starving young ones, while they are constantly at work to benefit rather than injure mankind: therefore protect them by all means.

Although I have thus far purposely refrained from saying anything about the woodpeckers, since the question of their usefulness or uselessness seems to be a point of dispute by many of our authorities, I find that in order to complete my line of utility in this particular direction I must refer to them for a moment only. You are well aware that the smaller species of woodpeckers, frequenting forest and garden trees, often perforate them with a most complete network of holes—whether in search of insects or their larvæ, as is probable, or for the purpose of sucking the sap, as has often been affirmed, we cannot say here: the fact remains the same. We know that they *do* do good in this way, in hunting for insects and their larvæ, which their extremely long barbed tongue is able to reach and *hook out* from a depth of several inches. Now while the woodpecker searches for large game, the nuthatches search for a size next smaller, leaving the titmouse or chicadee that smaller yet. But we have not finished our economy, since a small brown and white active little fellow, smaller even than the chicadee, with a long, slender, curved bill, steps in and picks up the leavings. So quietly does he work that you would hardly know he was there but for the echoed "faint, trilling sound" with which he beguiles the time, and by a sort of ventriloquism sets you looking for him in every direction but the right one. If all the other species I have mentioned do *good* in the economy of agriculture—taken in its broadest sense, though I think that I have not stepped without the boundary of my subject—this species, the

brown creeper, surely deserves a place in our list, and by no means an inferior one.

If I am not tiring you, while these birds are at work upon the trees let us see what is being done about the tree-tops and tender branchlets and leaves. What do we find? We are stationed in a woods of tall oak and pine trees: at our right are tall, thickly-branched and foliaged hemlocks; at our left, low pine shrubs. After fifteen minutes of patient waiting, during which time we have seen all the above-named birds at their proper work, as before shown, we catch sight of a small, fairy-like, winged creature, that flies from amidst the dark foliage of the hemlocks, and darts about the outside branches of the trees named with the agility and adroitness almost of a humming-bird; he clears the air of myriads of flies and gall insects,—which latter destroy the beauty and symmetry of our trees, as well as ruin greatly their foliage,—and even seeks the young grub on the leaves. This kinglet, or regulet, as it is often called, is another of those silent workers who keep down the hosts of destroyers of our forest and likewise useful trees, and without whose labors blight and insect ravages would overtake and finally destroy a large portion of our fine woods. Now note a curious fact: Out of the eighteen birds I have mentioned as particularly beneficial to agriculturists and farmers, and otherwise especially useful in nature's economy, all but five of them are more or less constant residents, wherever they occur, all the year round. The five I have mentioned, with a single exception, make up in their presence what they have lost in their absence, by the diligence of their pursuit of injurious insects, while, during their visits in other climates, they carry on their good work as they do here. I will pass over quickly the wrens, as strongly beneficial to gardens, and plants about the house, and hedge shrubs, from the numbers of caterpillars they eat; the flycatchers, which are of course beneficial; the cedar-bird, who, between taking the habits of a flycatcher at one time, and of a most miserable and despicable wretch of a fruit-eater at another, renders difficult the question as to which counterbalances the other in the long run; the Maryland yellow-throat ground warbler, so strict a guardian of the birches and alders of the hedges, who eats caterpillars that affect these shrubs ma-

terially; the thrushes; the warblers; and the vireos,—all of which are of the greatest benefit to mankind,—and pass at once to

PART III.

THE UTILITY OF BIRDS IN MIGRATION.

I am now aware that I have come to the most difficult, as it is the most important, part of my subject,—the utility of birds in migration. To treat of the utility of birds were a matter of comparative ease, as were it also to speak of them in their migration; but it is the combination, the *utility* in *migration*, that is the main point which I wish to emphasize. In order to do this we must first find out what birds migrate, in any numbers, at least; then, whence and where do they migrate? In the next place we must find what species are beneficial and why, and what injurious and why, to the farmer and agriculturist? We therefore omit mention of those species occupying a medium position, or whose economy is not yet thoroughly understood. We will omit entirely the raptores, or birds of prey, with the majority of all the other orders except the insessores, or perching birds proper, and confine ourselves to them alone. Let us proceed, then, to pick out those species of birds which are beneficial or injurious to the farmer in their migration, and see whence they come and whither they go, and note their economy.

We find that the great body of birds migrate twice a year,—in the spring, during the months of April and May, generally ending before the end of the latter month; and in the fall, during the middle to the last of September, and so on until late into the winter months. Birds migrating in the spring generally eat all they can get hold of to pay for the winter's privations, in case they have not had a full and usual allowance; in fall, the birds are weak and poor from their summer's work of rearing the young. In either case, they eat heartily all they can contain. The insectivorous birds find the insects just hatching from their chrysalids in the spring, while in the fall they are in the act of turning;—in either case, the birds find out these enemies to man, and attack them ravenously. In the fall the seed-eaters act as gleaners, and glean the fields, the trees, and vegetation generally, of the grain which often has fallen from the

stalk, having died from the ravages of insects, and often containing, at the time, the egg or pupa of the pest. In the spring the gleaners proceed to finish the work begun in the fall, so that it is safe to say that millions of the injurious pests are gotten rid of in this way. Moreover, the birds, in a sort of way, seem to strive to so regulate their migrations that *the time of the year will be the same with them wherever they are;* that is, starting say from northern Maine, where the majority have passed the summer in rearing their young, they progress westward and southward, as the fierce arctic weather presses them, so that they are continually in the region of late summer or early fall, in Florida, Louisiana, and other of their homes and haunts. In the spring they return in reverse order.

Birds migrate for at least two reasons;—the first, though we can hardly call it *automatic*, is yet more or less mechanical, and occasioned more or less directly by the weather; the other, we will briefly state, as impelled by lack of their peculiar and specific diet. I say specific, meaning it in the sense that the migrations of different species are at different times, since the food of each species differs more or less in its time of appearance; the fact being proven, with but little doubt, that the time of the appearing of the insect that is the chosen food of any species of bird is the same time at which that bird appears, both in the same locality. If, then, a bird's only occupation were securing enough to eat, the following of that occupation would answer all inquiries as to the causes of its migration, on the ground of variation of season alone. Unfortunately this explains but part of the question. Still, we have not reached our final question, but are rather laying out the ground and sifting the material, that we may the better determine our results.

Now it is well known that the robin congregates in large flocks before finally leaving for its southern and south-western home; yet it confines itself to the woods and fields at such times, where it undoubtedly does immense good in gathering insects and grubs, as well as diseased grain, and seeds wherein are laid the eggs of pests, or wherein are contained the grubs of the same. In the same way all our thrushes, though in much more limited numbers, raid upon the pests of the hedgerow and the woods in which they dwell. In the same way the bluebird congregates in

large flocks before final departure for its southern home, though a few remain with us all winter, and do the same for the fields and outskirts of the wood that the robin does for the shrubbery and interior of the forests. The titmice, though they hardly extensively migrate, cluster, and produce the same good locally, destroying everywhere as they go to and fro. In the fields on the sea-coast the shore-lark herds, one might almost say; but unfortunately it probably destroys more winter rye in one week than it can pay for all the rest of the year.

The ground-warblers seeking the shrubbery, and the tree-warblers the tree-tops, unite in scouring the blossomy foliage, and allowing the plant or tree to bud, blossom, and leaf or fruit, as the case may be, in the spring, while in the fall they eat the eggs and grub that would make sad havoc in the next year's foliage if allowed to remain and mature.

The vireos, ever busy among the foliage of our shade and ornamental trees at home, as also contributing their share in our forests, migrate in spring and fall, while they range from Nova Scotia to Texas, and return as they went. While the flycatchers confine themselves to the guardianship of the outside of the trees, these busy, working vireos, concealed among the foliage, are just as busy as they; the injurious insect and grub falls a prey to both.

Strangely does the golden-winged woodpecker, about the only bird of its kind in its tribe, look out after the limbs and branches of the trees in field, on edge of forest, and even in its interior, or search for insects and larvæ among their propagating ground, the rich moss of the damp, half-submerged meadow adjoining the woods, thus becoming, what many do not suspect, a most useful friend in keeping down the enemy.

Thus the good work goes on. Night-hawks and chimney-swallows cluster in immense flocks, and keep the upper air in constant agitation as they chase their prey hither and thither. Our delicate little humming-bird, ranging, in its varieties, from the Pacific to the Atlantic, and a single species from Texas to even the cold climate of Newfoundland, watches, with fairy-like, zealous guardianship, our flowers and fruit blossoms.

It remains but to speak of the *Fringillidæ*, or finches, with their allied family the starlings, which I have retained till the

last. Of these, I am uncertain as to the utility and practical economy of the pine-grosbeak, the purple finch, the crossbills, and the linnets, and will leave these, hoping that some future careful investigator will give us the results of a series of investigations as to the relation existing between these birds and the food they seek and require. All are migratory, and all periodical in their abundance or rarity in any given locality. Future investigation will doubtless enlighten us with regard to the *special* food of many of the birds really useful in agriculture, but whose precise economy is as yet either not known at all, or imperfectly known at best. Of these birds I would call especial attention to the yellowbird, or thistle-bird, as it is often called, as occupying a prominent place. It is eminently a seed-eater, and feeds principally in the fall, when its food is gleanings, and when the gleanings are worm-eaten, worm- or larva-inhabiting, and otherwise unfruitful seeds. It is then eminently a gleaner in garden and in field, by roadside and in hedgerows. The yellowbird is found migrating from the Atlantic to the Pacific, and from the fur countries to far "down South."

The snowbird and the tree sparrow follow close. They both come together and go together. Immense flocks fill the deserted grain fields and feed upon the gleanings, picking up occasional beetles and grubs that come in their way. Both are found from Labrador to the Rocky Mountains. They migrate together, and they breed together; they are alike most beneficial in every way to the farmer and agriculturist. The song-sparrow clears the hedges; the swamp-sparrow abounds in swampy thickets; the grass-finch, or bay-winged bunting, perfectly swarms in fields and along the outskirts of the woods, while the white-throated sparrow is equally abundant in groves and thickets; each migrates in immense flocks; each is found from the Atlantic nearly or quite to the Pacific; each has his place and does not interfere with the other; and each does good in his peculiar and separate line, and, so to speak, aims at remedying a peculiar evil;—each is highly beneficial in every sense of the word. Along the sea-coasts the Savannah sparrow fills *its* place. In the woodlands, and along mountainous districts, both seashore and interior, the fox-sparrow, the Canadian "*Rusingel*," that most beautiful songster of the cold regions, migrates in large quan-

tities, and helps to retain foliage to our shrubs and trees from the northern Atlantic to the Rocky Mountains, at the very least.

So far one would imagine that the economy and utility of bird-life in nature were all smiles. Lest any one should be deceived, let me say, Vow vengeance, deep and continual, on the remaining families of which I speak. Let bobolink and blackbird alike share the odium of utter uselessness. They swarm in tens of thousands; they gormandize; they destroy every seed, grain, or eatable they can come across, and I verily believe are only maddened because they cannot get more. They have no feeling but for their own crops, and when they have eaten to excess, amuse themselves by tearing with beak and claws anything of value that they can lay hold of. Thank fortune, they are less abundant now than ten years ago even. Were they wholly exterminated, it would be thousands of dollars in the pocket of every farmer in our country.

But I have already overrun my time. I have failed to say one half the things I had intended to make prominent here; so, thanking you all for your kindly attention, I will turn my last page.

THE QUALITY OF SEEDS.

BY DR. ALBERT R. LEDOUX, OF NEW YORK, RECENTLY DIRECTOR OF THE N. C. AGRICULTURAL EXPERIMENT STATION.

[This paper, from which we have dropped strictly local paragraphs, was read at the meeting for the organization of the American Agricultural Association in the city of New York, and is reprinted in our volume by permission of the secretary of that association, J. H. Reall, Esq., who has furnished us with the illustrations.—SEC.]

With a deep sense of the honor you have done me in requesting my presence here to-day, I respectfully ask your attention to one of the most vital and practical of the many subjects with which our farmers have to deal.

I am amazed, sir, when I take up even the best of our agricultural journals, to see how little, comparatively, is said about seeds and seed-testing. The letters and advice about soils, tillage, fertilization, etc., are many, but how few seem to realize that unless the seed is sound and pure their labor is wasted or doubled. There can be but two plausible reasons assigned for this apparent indifference. Either our seeds are so pure and sound as to warrant this apathy, or else the attention of our farmers has not been called to the importance of the subject.

In April, 1869, hardly more than ten years ago, a farmer in Saxony forwarded to Professor Nobbe, director of the experiment station at Tharand, some four or five samples of grass-seed which he had bought, and asked for their botanical identification. The examination revealed the surprising fact that *scarcely 30 per cent., of one of the samples at least, was of the species indicated by the label attached.* This discovery led Dr. Nobbe to undertake an examination of the stock of prominent seed-houses in Germany, and the results, published in his work of over 600 pages, have been the means of creating an entirely new branch of scientific investigation for the student, and for

the farmer another protection against intentional or unwitting deception.

Among the visible results of Prof. Nobbe's work is the establishment in Europe of no less than forty-five experiment stations, whose chief duty is the examination of commercial seeds. Nobbe himself has tested over 5,000 samples. The unseen benefits of such work, who can number! We can sum up the results of Dr. Nobbe's first series of investigations as follows:

The average per cent. of pure seed in commercial samples was found to be 59.

The average per cent. of foreign substances was 41.

Of the 59 per cent. of seeds, which were what they were represented to be, only 18 per cent. were capable of germinating.

A sample of orchard-grass *(Dactylis glomerata)* contained the seeds of forty-five other plants.

A sample of meadow fox-tail *(Alopecurus pratensis)* contained 95 per cent. of dead seed.

Three tons of seed, sold as red clover *(Trifolium pratense)*, contained two tons of yellow clover *(Trifolium agrarium)*.

FIG. 1.—Seed and chaff, natural size and enlarged, of meadow soft grass (*Holcus lanatus*).

Old seeds were renovated by boiling, dyeing, and roasting. Weed seeds were stained, and used to adulterate lots of expensive seeds. English seedsmen sold in 1869 over ten tons of

poor turnip seed, disguised so as to represent a more valuable article. In Bohemia and elsewhere large factories for the manufacture of seeds from quartz were running, with large warehouses at Hamburg and other commercial centres. The quartz grains, colored to order, were selling for $50 per ton, and were largely used to adulterate clover. An ordinary observer will never detect the fraud, even when the sample is adulterated 25 per cent. with these stones. The flowers of various grass varieties, especially orchard grass, from which the seed had been removed, were frequently sold as genuine grass-seed.

Men, woman, and children were regularly employed in Bavaria and Austria to collect from the roadsides and ditches seeds of weeds and grasses of all kinds. These collections were bought by agents, who shipped them to England and elsewhere to be sorted, labelled, and sold.

This species of labelling reminds me, sir, of the trick which Mark Twain's companion, Blucher, played upon an aged and unsuspecting relative. Previously to embarking for his homeward voyage, he gathered a quantity of bones, old iron, and pebbles, and spent his leisure moments on the passage in labelling them. For example, one part of the jaw of a horse, he marked "*Fragment of a Russian general.*" Another—a stone—he broke in half, and marked one piece "*Chunk busted from the pulpit of Demosthenes,*" and the other "*Darnick from the tomb of Abelard and Heloise.*" A mild and comparatively harmless species of deception, while that practised by the English seedsmen, in the extent and duration of the injury, toil, and loss inflicted, can scarcely find a parallel in the history of fraud.

Such are a few of the facts discovered by Dr. Nobbe, and upon which has been builded the science of seed analysis. That a seed shall produce a healthy plant of the proper species, it must be well developed, sound, and genuine: all this without considering the time, place, and manner of planting, or the method of cultivation.

The student of agriculture should be taught to distinguish good seed from bad, recognize impurities, and identify the germs of weeds. There should be a special branch of instruction in this line in all our agricultural colleges. Most of you, no doubt, can distinguish at a glance the common grass, grain,

and garden seeds, but how many gentlemen here to-day can describe the appearance of the seeds of half a dozen common weeds? How many botanists, even, can identify the most familiar plants by their seeds alone?

I will not take the time to describe the methods employed in experiment stations to make a complete seed analysis. I will do little more than name them.

FIG. 2.—Blue-weed (*Echium vulgare*), natural size and enlarged, in different positions. One of our worst weeds.

1. *Gravity.*—From their specific gravity we learn the probable quality and age of seeds. Those gathered before maturity, and those dry with age, are comparatively light. Light seeds produce inferior plants, if any.

2. *Preliminary Examination.*—Good seeds are shiny, smooth, and full; have a fresh smell, or none; sink when placed in water; spring upward like "pop-corn" when thrown on a heated metal plate. Poor seeds often smell musty, and stick together; are dirty, soiling the hands; of a pale color; float when placed in water; are quietly charred when placed on a hot plate.

3. *Determination of Impurities.*—This is effected by separation from dirt, chaff, and foreign seeds, by hand (I shall call "foreign" all seeds in any sample which are not what the lot was represented to be), aided by certain sieves, special mechanical contrivances, and by the microscope. The impurities are weighed.

4. *Identification of Foreign Seeds.*—This requires experience on the part of the analyst. The standard seed collections of Prof. Hennig, and Nobbe's accurate drawings and accompanying tables, are invaluable aids.

5. *Determination of the Germinating Power.*—Here, too, experience is needed, as well as a knowledge of the habits of

different seeds. In nature we find the widest extremes, from the seeds of the cress, radish, etc., which, twelve hours after they are detached from the parent stem, begin to shoot their tiny rootlets into the soil, to the acorn, cherry, and other fruits, whose duration of "seed inertia" is often two years.

FIG. 1.—Seeds of flax dodder (*Cuscuta epilinum*), natural size and enlarged.

FIG. 2.—Lupine dodder (*C. lupini-formis*), natural size and enlarged.

FIG. 3.—European dodder (*C. Europea*), natural size and enlarged.

Elaborate experiments have been made to show that the time required to produce artificial germination in seeds of grains, grasses, and other lesser plants, is ten days on an average. The aim of the analyst is to produce artificial germination under the most favorable circumstances. An apparatus has been contrived by which the seeds may be sprouted under constant and normal conditions of shade, moisture, and temperature. Various other expedients have to be resorted to in special cases, such as conducting the experiment in moist sand, in blotting-paper, etc. I will not detail them here.

I have upon the table three sets of sprouting apparatus, in which 200 each of red clover, cabbage, and orchard-grass seed were placed four days ago. Every other day the sprouted seeds are removed and counted. After ten or twelve days the experiment is discontinued, and certain allowance made for the seeds still remaining hard, though exhibiting no signs of sprouting. The apparatus is made of porous earthen-ware, and allows the seeds to be kept constantly moist, but not to stand in water, which would "drown" them, as we say in the laboratory. The temperature must remain between 15° and 18° Centigrade.

Having briefly presented the outlines of the work of seed analysis, it remains to illustrate the subject by means of a practical example. I will take such an example at random from the report of the experiment station at Tharand. From a lot of

commercial red-clover seed, a carefully drawn sample of two ounces (59 grams) in weight was taken. It contained,—seeds of red clover, 94 per cent.; impurities, 6 per cent. Of the 94 per cent. of pure seeds, 60 per cent., or three fifths, was found to be incapable of germinating. The impurities consisted of sand, chaff, and seeds other than red clover. A pound contained no less than 14,400 foreign seeds.

Pursuing the investigation still further, these unwelcome intruders were found to be of forty-four distinct species, as follows: Thistle, horse sorrel, sheep sorrel, milkweed, dandelion, knotweed, bottle-grass, knawzel, bladder campion, corn spurrey, star-wort, penny cress, rabbit clover, Swedish clover, zigzag clover, hop clover, white clover, valerian, speedwell, blue violet, marsh violet, pansy, rib-grass, plantain, timothy, poppy, forget-me-not, black medick, burdock, darnell, cranebill, goosegrass, spurge, blueweed, wild carrot, ox-eye daisy, pigweed, chickweed, winter-cress, sand-wort, pimpernell, dodder, and alyssum.

FIG. 7.—1. 2. 3.
Seeds of Butter-weed (*Erigeron canadense*); 2, natural size; 1, enlarged, dry; 3, enlarged, wet.

While we might tolerate an occasional forget-me-not, pansy, or poppy, and might welcome the timothy and white clover, who would want to sow the blueweed, daisy, burdock, darnell, and dodder? Yet this clover seed was above the average in purity, this average being, as already stated, forty-one pounds of pure seed in every hundred.

A sample of hemp seed contained,—pure seed, 93 per cent.; impurities, 7 per cent. The foreign seeds were of forty-five

distinct varieties, including the flax-dodder (of which more anon), and numbered over 6,000 per pound. A sample of French rye-grass contained 31 per cent. of pure seeds, 40 per cent. of foreign seeds, and 29 per cent. of sand, etc. The interloping seeds numbered over 25,000 per pound.

FIG. 5.—Seed and chaff, natural size and enlarged, of common velvet grass (*Holcus mollis*).

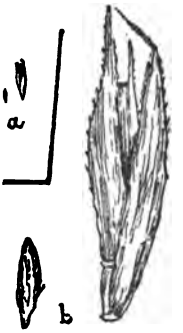


FIG. 6.—Seed and flower of orchard grass, natural size (*a*) and enlarged (*b*).

Let us go back to the sample of clover for a minute. From the data I have given, we can easily calculate that the farmer who sowed this stuff upon his field, distributed with it the germs of six hundred and eighty (680) blueweeds, twenty-one thousand and four hundred (21,400) dodder, and five thousand nine hundred and eighty-three (5,983) daisies per acre, to say nothing of the other useless or hurtful seeds to the number of two hundred and fifteen thousand eight hundred and forty-three (215,843) on every acre.

We can now realize his misfortune;—but this is not all. A single plant of blueweed has produced by actual count fourteen thousand seven hundred and thirty-five (14,735) seeds, of which eight thousand two hundred and fifty-five (8,255) sprouted.

FIG. 7.—Buckwheat, with seeds of goose-grass, knot-weed, convolvulus, etc.

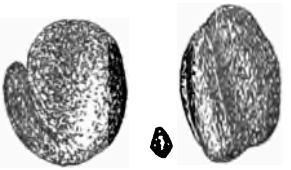


FIG. 8.—False flax (*Camelina dentata*), natural size, and enlarged in different positions.

What a world of trouble all this means! No wonder English farmers have the proverb,—

"One year's seeding
Is seven years' weeding."

I turn now to the consideration of American seeds. I fear, sir, that you will think I have been a long time in reaching my subject, but I deemed that some preliminary explanation was necessary. I think that I have said enough to convince you all that, *on account of the wide-spread adulteration of European seeds, if for no other reason, we should at least exercise care and vigilance in our purchases from American seedsmen*—especially since they import largely from all European countries. During the year ending June 30, 1879, the value of garden, agricultural, and horticultural seeds imported into the United States amounted to nearly $700,000. The exported seeds of the same class were valued at $2,140,533.

Let any one examine Dr. Gray's Manual, and he will find hundreds of weeds described which are not native, but have been introduced from abroad. Writing upon this subject, my kind friend, Dr. Thurber, uses editorially the following language: In the natural distribution of seeds, it would appear that the scattering of the seeds of weeds was most carefully provided for. But, however abundantly these are disseminated by natural agencies, the careless farmer sows them broadcast by the handful, and does what nature cannot do,—*he puts them in well-prepared soil*, where they will be sure to grow. To take an illustration in season: In this very month (of March) hundreds of farmers will be sowing their clover "on the last snow," as many try to do. Next summer, or later, we shall have from some of these same farmers letters and specimens. The letters will be to this purport:

"A new weed has appeared in our fields or meadows; threatens to kill out everything else. What is it, and how shall we get rid of it? It was never known here before this year. Where *did* it come from?" Of course we shall try to answer each inquiry as well as we can. The "Where did it come from?" we can answer now: you carefully sowed it that cool March day with your clover.

I will bring forward one more proof that American seeds are certainly often impure. It is that the European experiment stations and botanists are constantly finding weed seeds in importations from America. In Dr. Nobbe's report again and again occurs the phrase, "introduced from America," after the description of many species of weeds. You will notice, sir, that thus far I have argued from induction only. I will now proceed to give the results of actual seed examinations. I must pause just here to do a very pleasant duty. That duty is to assure you of my confidence in the honesty of our great American seedsmen. I find no *manufactories* among them, nor establishments for seed "doctoring."

Impure clover seed.

Pure clover seed, enlarged.

Among Prof. Johnson's examinations of Connecticut seeds, I find no mention of even one "*wooden nutmeg.*" I have never seen a single specimen of "*shoe-peg oats.*"

Though themselves often deceived, and ignorantly deceiving, no class of business men are more upright. To name *one* of them, at least, is to inspire confidence and gratitude wherever there is *gardening for pleasure* or *profit.*

After careful inquiry I find that it is not yet four years since the first experiment with a regular sprouting apparatus was made in the United States, and all the tests which I am about to report have been made at one or the other of our two American experiment stations. I have arranged the results of fifty-six reliable tests in the following tables:

I.—American Seed-Tests.

Common Name of Seed.	Where obtained.	Per cent. of pure seed.	Seeds in 100 capable of germinating.
Ky. blue-grass	New Haven	92	5
Red-top	"	55	42
"	Philadelphia	14	46
Orchard grass	New Haven	81	48
"	Chapel Hill, N. C.	95	67
"	" "	91	85
"	Raleigh, N. C.	91	58
"	Philadelphia	100	69
Timothy	Chapel Hill	67	62
"	"	70	23
"	New Haven	98	95
English rye-grass	"	94	66
Lucerne	"	100	68
Golden Millet	Rockingham, N. C.	100	40
Red clover	New Haven	94	77
"	"		35
"	"		29
"	Philadelphia	94	78
"	"	98	82
"	New York city	87	93
"	Raleigh, N. C.	98	79
"	Durham, N. C.	90	73
"	Chapel Hill, N. C.	95	83
White clover	Wake Forest, N. C.	97	3
Turnip	New Haven	100	56
"	Weaver's Creek, N. C.	99	94
Radish	New Haven	100	78
"	Chapel Hill	95	98
"	U. S. Com. Ag	100	67
"	"	100	98
Wheat	"	100	99
Barley	"	100	98
Rye	Moyock, N. C.	100	97
Oats	U. S. Com. Ag	100	98
Lettuce	New Haven	100	40
Beet	U. S. Com. Ag	98	81
"	"	98	62

I.—AMERICAN SEED-TESTS—*Continued.*

Common Name of Seed.	Where obtained.	Per cent. of pure seed.	Seeds in 100 capable of germinating.
Beet	U. S. Com. Ag	99	89
Mangel Wurzel	Rochester	100	50
Carrot	U. S. Com. Ag	96	34
"	"	87	57
Watermelon	"	100	74
"	"	100	75
Parsnip	"	100	29
Onion	"	100	63
Tomato	"	100	96
Celery	"	100	24
Broccoli	"	100	88
Cabbage	"	100	70
"	Fonta Flora, N. C.	100	100
Cauliflower	U. S. Com. Ag	100	65
Rhubarb	"	100	16
Okra	"	100	62

We will now examine these results with reference to the quality of the samples, the vitality of the pure seed, and the character of the impurities.

The German tables of average purity and vitality, based as they are on the investigation of hundreds of samples, will serve to give us an idea, by comparison, of the quality of our American seeds. Few in number as our tests have been, we shall still find the following table of extreme interest, if not perfectly satisfactory:

II.—Table of Comparisons.

Seed.	Per cent. of pure seed.		Seeds in 100 capable of germinating.	
	U. States.	Germany.	U. States.	Germany.
Ky. blue-grass	92	51	5	11
Red-top	89	25	44	21
Orchard grass	92	47	65	22
Timothy	78	94	60	82
English rye-grass	94	95	66	73
Lucerne	100	95	68	76
Red clover	93	95	70	82
White clover	97	93	3	65
Turnip	99	97	75	79
Radish	99	98	85	91
Wheat	100	98	99	95
Barley	100	99	98	88
Oats	100	99	98	74
Lettuce	100	96	40	77
Beet	98	98	77	71
Carrot	91	86	45	59
Parsnip	100	95	29	17
Onion	100	99	63	50
Tomato	100	96	98	77
Celery	100	97	24	32
Mangel Wurzel	100	98	50	71
Cabbage	100	99	85	79
Cauliflower	100	99	65	87

One more table will give us a clearer comprehension of the subject.

III.—Table of Comparison.

Seed.	Per cent. of pure seed.		Seeds in 100 capable of germinating.	
	U. States.	Germany.	U. States.	Germany.
Grasses	79	62	50	42
Clovers	93	94	69	79*
Garden vegetables	100	99	98	86
Grain	99	96	61	66

The averages are obtained from Table II.

The following table shows the *average* obtained by Prof. Beal in a large number of seed tests made at the college farm at Lansing. The seeds were planted in the ground, or sprouted between folds of moistened paper:

Seeds.	Seeds in 100 capable of germinating.	Seeds.	Seeds in 100 capable of germinating.
Salsify	14	Bent-grass	5
Onions	47	English rye-grass	5
Cabbage	46	Meadow-grass	2
Lettuce	57	Schroeder's Bromus	62
Carrot	51	Sweet-scented vernal	15
Beet	50	Orchard grass	50
Parsnip	32	Hungarian grass	56
Cucumber	59	Yellow oat-grass	11
Squash	13	Timothy	69
Red clover	32	Italian rye-grass	21
Bokhara clover	49	Red-top	14
Italian clover	70	Kentucky blue-grass	4

*I have omitted white clover in this line.

Lucerne	87	Reed canary-grass	4
White clover	88	Meadow fox-tail	4
Alsike clover	64	Crested dogs'-tail	8
Fescue	71		

It needs but a brief glance at this table to show us that Prof. Beal's experiments tend to lower very materially our estimate of the quality of American seeds. I have not incorporated these tests with the others, because Prof. Beal does not state the percentage of pure seeds present in the sample, and because tests made in the soil cannot be as fair as those made in the sprouting apparatus, on account of the additional factors that affect the results; nor can the normal conditions be so accurately observed.

We see that our grass seed is cleaner than the European, and its vitality greater. Still there is room for great improvement. Our clover is cleaner, but of inferior vitality. Our garden vegetables are superior in every way. Although very interesting, I cannot expect for these conclusions an unqualified acceptance. Our tests have been too few as yet to give our results an undisputed title to credibility. This the future must, and, I trust will do.

It remains for me to speak, in conclusion, of the *impurities* which make up *21 per cent. of our grasses, and 7 per cent. of our clovers*. I shall do so very briefly. They are of two kinds—dirt and foreign seeds. Under dirt are classed sand, stones, sticks, chaff, etc. We have already seen what were the impurities in European seeds. Those found in our American seeds are of the same general character. Seeds of sedge, plantain, knotweed, bed-straw, morning glory, dodder, and other weeds and poisonous plants, have been discovered among samples of clover seed.

In Connecticut the seeds of red-top were gathered before perfectly ripe, and sold as "blue-top" grass for $2 per bushel. Such seeds, it is needless to say, never germinated, or, at best, produced inferior plants. It is not uncommon in this country to find samples of orchard grass, of which *80 per cent. are simply the flower, containing no seed.*

In one sample of clover seed, from a reputable firm, sold as red clover, I found *13 per cent.* of *Swedish clover*, and *seeds of the clover-dodder at the rate of 720 per pound.* This lot of seed I traced far enough to learn that it came from the West, and was not imported. It deserves more than a passing notice. Many of our farmers are familiar with the flax-dodder *(Cuscuta epilinum)*, which, by the way, drove hemp-growing out of Central North Carolina, and opened the way for cotton culture. The clover-dodder *(Cuscuta trifolii)* is the greatest pest of German farmers.

Whole sections of country are ravaged by this parasite, and the people have been compelled to abandon the cultivation of a

FIG. X.—Clover infested with dodder, showing manner of attack.

clover. The *Cuscuta trifolii* bears flowers not unlike the morning glory *(Convolvulus)*, and develops perfect seeds. When ripe

the seeds fall to the ground, and send up tiny wiry arms in search of a clover plant. It is a matter of life or lingering death to the dodder whether or not it finds clover. With unerring instinct it creeps along until it reaches the doomed plant, which it surrounds, and covers with a complete net-work of runners. Each runner sends forth *papillæ* at every point of contact, which tap and suck out the life-blood of the unfortunate captive. The accompanying diagram (Fig. X) will serve to illustrate the manner of growth of the *cuscuta*. It is true that many species of weeds, very injurious in certain climates and soils, are comparatively innocent in others. It would be a fearful national calamity should the clover-dodder obtain a footing in our country.

When our farmers found that they were being imposed upon by unscrupulous dealers in fertilizers, they instituted various forms of state control and inspection. In this they were seconded by the better class of fertilizer manufacturers. When we begin to realize the importance of pure, fresh seed, we shall not only experiment for ourselves, as have Dr. Sturtevant and others with such interesting results, but will establish in our broad land not two, but many, experiment stations, where the honest seedsman and the cautious farmer can ascertain what they sell and buy.*

Such an institution could have saved a former United States commissioner of agriculture considerable annoyance. He purchased and distributed throughout the country tomato seed, which, unbeknown to him, had been cooked at a Baltimore canned-goods factory. A sprouting experiment would have shown at once that they were worthless. If it were not for the proverbial majesty and protection of the laws of this city, I should hardly dare remind the New York gentlemen here to-night of the way a Mexican *sold* them—judges, bankers, botanists, preachers, and all—sold them Okra seeds, which cost him fifteen cents per thousand, as the seeds of a rare and wonderful plant,—"Cocatel—Lily of Mexico,"—at the rate of *three for a dollar*. This happened not three years ago.

I am aware, sir, that I have done little more to-day than

* When this address was delivered there were only two experiment stations; since then others have been established.

throw out suggestions, and point to probabilities; that our seed examinations have been too few to warrant absolute conclusions or unqualified generalizations. If my regular chemical work will allow, I shall endeavor to collect facts and figures that will place me in a position by another year to make a report more worthy the importance of the subject.

WHAT SHALL WE DO WITH MILK?

EXTRACTS FROM AN ADDRESS BEFORE THE MASSACHUSETTS BOARD OF AGRICULTURE.

BY HENRY E. ALVORD.

Rapid as the growing demand for milk has been, the increase in production has fully kept up with it, and for some time the supply has exceeded the demand. In many parts of the state, a surplus of milk is now to be found during parts of the year, if not most of the time, and the question arises, What is the best disposition to make of it?

The milk question thus presents itself as one of the interesting and important topics of the day, among the farmers of Massachusetts.

The consideration of this subject naturally divides itself into three parts, as follows:

1st. Shall the milk be sold?

2d. How shall it be sold?

3d. If not sold, what shall be done with it?

I. Shall the Milk be Sold?

This is a question which cannot be briefly answered, in the abstract. The reply must depend upon the various conditions which surround the farm as to which the inquiry is made.

On general principles, it is safe to say that it is poor policy to sell milk; that milk-farming is poor farming, except under most guarded conditions. But many exceptions must at once

be made to cover cases where all the circumstances are carefully considered, and the fundamental objections resolutely removed.

One great trouble is, that the steady cash income is so alluring as to often become deceptive. The credit side is pleasingly felt, while the debit side is not fully computed. When the interest on the cost of the cow is given, and the cost of her feed and the returns from the milk sales, the story is but half told. The depreciation in the value of the cow herself, the time of men and horses, the wear and tear of wagons and harness, and the heavy losses on cans, besides incidentals of ice-cooling and so on, are too often overlooked, or rated below their actual cost. Every one with any experience knows that the business of selling milk, whether wholesale or retail—entirely distinct from the actual cost of production—is one which involves constant expenditures which, however small singly, are so great in the aggregate as to materially reduce the margin of profit, if any accrues.

The most serious objection to selling milk, however, is the daily drafts made upon the fertility of the farm. These are small and imperceptible, but they are sure, and when examined by the year, become formidable. They show that the constant production and sale of milk is, in effect, as year succeeds year, nothing more nor less than selling the farm itself, by the gallon or by the pound.

The better to appreciate this, let us consider of what the article milk is composed.

The following table is compiled from the writings of two eminent dairy chemists,—Dr. Henry L. De Klenze of Munich, and Dr. Aug. Voelcker of London. The chemical constituents of milk, as thus exhibited, are the average results of a very large number of analyses.

For convenience of reference, two other tables are also here inserted.

Composition of 1,000 Pounds of Milk.

			Pounds.		Pounds.
1,000 lbs. of Milk.	160 lbs. of Cream.	Water,	121.0	Water,	121.000
		Fat,	29.5	Solid,	20.060
				Fluid,	8.850
				Volatile,	0.590
		Casein,	5.0	Carbon,	2.655
				Hydrogen,	0.353
				Nitrogen,	0.770
				Oxygen,	1.090
				Sulphur,	0.055
				Phosphorus,	0.077
		Albumen,	0.5	Carbon,	0.267
				Hydrogen,	0.035
				Nitrogen,	0.077
				Oxygen,	0.113
				Sulphur,	0.008
		Sugar,	8.5	Carbon,	1.400
				Hydrogen,	0.213
				Oxygen,	1.712
				Water,	0.175
		Ash,	0.5	Phos. Acid,	0.135
				Lime,	0.130
				Potash,	0.085
				Chlorine,	0.080
				Soda,	0.047
				Magnesia,	0.020
				Iron,	0.003
			160.0 lbs.		160.000
	840 lbs. of Skim-milk.	Water,	754.0	Water,	754.000
		Fat,	5.5	Solid,	3.740
				Fluid,	1.650
				Volatile,	0.110
		Albumen,	3.5	Carbon,	1.873
				Hydrogen,	0.245
				Nitrogen,	0.540
				Oxygen,	0.786
				Sulphur,	0.056
		Casein,	30.0	Carbon,	16.071
				Hydrogen,	2.142
				Nitrogen,	4.623
				Oxygen,	6.609
				Sulphur,	0.333
				Phosphorus,	0.222
		Sugar,	40.0	Carbon,	16.000
				Hydrogen,	2.440
				Oxygen,	19.560
				Water,	2.000
		Ash,	7.0	Phos. Acid,	1.890
				Lime,	1.820
				Potash,	1.190
				Chlorine,	1.120
				Soda,	0.665
				Magnesia,	0.280
				Iron,	0.035
			1,000 lbs.		1,000.000

Main Elements of Soil Fertility in 1,000 Pounds of Milk, with Values.

	1,000 lbs. of Milk.		1,000 lbs. Milk, composed of				160 lbs. Cream, composed of			
			840 lbs. Skim-Milk.		160 lbs. Cream.		126 lbs. Buttermilk.		34 lbs. Butter.	
	Weight. lbs.	Value.	Weight. lbs.	Value.	Weight. lbs.	Value.	Weight. lbs.	Value.	Weight. lbs.	Value.
Nitrogen, . . .	6.010	$1.263	5.163	$1.085	.847	$ .178	.801	$ .168	.046	$ .010
Phos. Acid, . . .	2.247	.202	2.112	.190	.135	.012	.108	.010	.027	.002
Potash, . . .	1.275	.076	1.190	.071	.085	.005	.068	.004	.017	.001
Lime, ...	2.950	. . .	1.820	. . .	.130	. . .	.104	. . .	.026	. . .
	12.482	$1.541	10.285	$1.346	1.197	$ .195	1.081	$ .182	.116	$ .013

Average Analysis of Milk, its Parts and Products.

	Milk.	100 Parts Milk Equal		100 Parts Skim-Milk Equal		100 Parts Cream Equal	
		16 Parts Cream.	84 Parts Skim-Milk.	7½ Parts Cheese.	92½ Parts Whey.	21 Parts Butter.	79 Parts Buttermilk.
Water, . . .	87.50	76.00	90.00	45.44	93.32	12.00	91.10
Fat, . . .	3.50	17.75	.65	6.40	.38	86.00	.78
Casein, . . .	3.50	3.25	3.60	41.76	.43	1.00	4.09
Albumen, . .	.40	.05	.30	1.60	.57	.12	.30
Sugar, . . .	4.35	2.75	4.60	3.52	4.66	.80	3.43
Ash, . . .	.75	.20	.85	1.28	.64	.08	.30
100 Parts, . .	100.00	100.00	100.00	100.00	100.00	100.00	100.00

The table shows that in every one thousand pounds of average fresh mile, or whole milk, there are present 6 lbs. of nitrogen, 2¼ lbs. of phosphoric acid, and 1¼ lbs of potash (and 2 lbs. of lime). At the prices which are fixed as the value of these materials by the state inspectors of fertilizers, this portion of the milk is worth $1.54. That is, to return to the farm in commercial fertilizers, or their equivalent, what is removed by every 1,000 lbs. of milk sold, would cost, at present market rates, $1.54, besides the hauling and handling. So, a gallon of milk is worth a cent and a half on the compost heap.

It may be better to look at this view of the subject in another way. It is certain that no one can afford to make milk to sell unless good, productive cows are kept. The cows of Massachusetts do not average 2,000 quarts of milk a year,* while no cow is good enough to sell milk from that does not give more than this. It is easy in these days to find better ones. There are dairies of Holstein cows in the country that average 5,000 quarts of milk per year and head, for the herd.

Let us assume, then, that no cow is fit for the business that does not give 2,200 quarts, or 4,768 pounds, of milk annually. If this amount of milk per cow is sold whole from the farm, its manurial elements will consist of 28.63 pounds of nitrogen, worth $6.01; 10.71 pounds of soluble phosphoric acid, worth $1.07; and 7.03 pounds of potash, worth 42 cents,—in all $7.50.

This sum of money being expended in manures of any kind, by way of restitution, they cannot, by the closest economy, be obtained and applied without a further cost of fully half a dollar. This makes the round sum of eight dollars per cow, and when all other considerations of waste and losses from being unavailable are taken into account, it is reasonable to conclude that the sale of all the milk of a 2,200 quart cow removes from the farm on which she is kept what will cost at least ten dollars a year to make good again.

This item of expense in selling milk has been dwelt upon at length, because it is so often overlooked or under-estimated, notwithstanding its importance. How many milk producers are there in this state, who make it a rule to expend annually,

* The same is true in our own state.—SEC.

for every cow kept, from eight to ten dollars for manure from off the farm, to be applied especially to the pastures and grass lands? This return is made by many, in an indefinite and uncertain way, by the purchase of grain and other food for their stock. If this is done systematically, and the manure made is fully saved, the necessary restoration to the soil can be thus advantageously accomplished. It will not do to assume, however, that if one feeds a cow well, even provided all the grain be purchased, full return is thus made to the soil for the milk sold. Without going much into details, let it be supposed that a cow is fed for two hundred days in the year a ration of four pounds corn-meal, four pounds wheat bran, and one pound cotton-seed meal, and that half a ton of bran is allowed to "help out the pasture," and that all this is purchased outside and fed on the farm. The manurial value of the feeding stuffs, computed on the same basis as in the case of the milk, amounts in round numbers to $7.00 per cow. This leaves only a small balance, it is true, between the sales and purchases of fertility (so to speak), but it is still on the wrong side. Buying feed, therefore, even on a liberal scale, does not offset the injury to the farm resulting from the sale of the whole milk.

The answer to the question, Shall the milk be sold? may therefore be in the affirmative, only *provided* the conditions are all they should be.

First. The possession of productive cows.

Second. A steady and satisfactory market for the whole product.

Third. Such returns as shall certainly cover all the special costs of selling milk, and still leave a fair profit.

Reduce this to figures, and it means an average selling price of four cents or more per quart for the year, and never less than thirty cents for a two-gallon can, or a gross receipt (including a calf) of $85 to $100 or more per year from every cow.

II. How shall the Milk be Sold?

There is but a single answer. Milk must pass more directly from the producer to the consumer. A quart of milk is too small and too perishable an article to be often handled, and it has not value enough to yield a profit to several persons.

To bring about any sort of healthy condition to the milk business, the present system must be exactly reversed. A fair price must be fixed as that to be received by the producer, based upon his investment and the current cost of production, and allowing a proper profit. There is no reason for much fluctuation. Generally, when certain articles are dear, others are cheap (a good season usually follows a bad one), or, at least, the laws of compensation and average are such that the actual cost of making milk three hundred and sixty-five days in the year is just about the same, year after year. There is difference in localities; but we are now considering milk made at places which are so situated as to be able to reach a market. For all such, in this state, I am inclined to place the full cost of producing a quart of good milk, ready for market, at three cents the year through, and hence believe the farmer's price should be nearly or quite four cents, yielding him an actual profit of at least three cents a gallon. This is none too much—certainly no more than the producer's share; it amounts to not over six cents a day on every cow in the herd.

A fair price for the farmer is the starting-point. Next, a fair charge for whatever transportation may be necessary by road or rail, and then a fair compensation for the service of collection, distribution, and delivery. The sum of these gives the final cost to the consumer. The intermediate charges—the shares received by the middle men—must be kept within bounds, for the retail price must have a proper relation to the cost of other articles of food. The consumer must not be called upon to pay too much, and need not be if the business is properly systematized.

I am a firm believer in coöperation in almost all branches of dairying, always provided it is properly managed. In the business of milk-selling the advantages of coöperation are manifest, no matter whether the sales be great or small.

In villages with but two or three or a dozen different milk routes, where the producing farmers deliver direct to consumers, a little friendly coöperation, instead of the cut-throat competition which so often exists, would be great gain to all concerned.

With the next grade in the business, supplying large towns

and small cities, the best course is to establish a milk-depot, —*dairy* would be the true name for it,—but I suppose it would generally be called a creamery. To this central place the milk produced for sale should go, as generally as possible, and from it the deliveries should be made. They would be not only of milk, but of all its varied products, for the dairy or depot would be fitted to convert surplus milk into butter or cheese; and also to supply milk, cream, sour milk, buttermilk, and cottage or "Dutch" cheese. Such an establishment might be a joint-stock concern, owned and controlled by the milk producers, or the business of a single proprietor or of a firm. In either case, the dairy would probably do a wholesale business, and also keep several teams of its own delivering to families.

Creameries of this character were established in Orange county, N. Y., some years ago, and so long as they were conducted on the plan for which they were built, exerted a salutary influence upon the milk business of the county, which is very large. (This one county sends as much milk to New York daily as the whole supply of the city of Boston.) But through negligence and mismanagement the manufacture of butter and cheese at these creameries has largely ceased, and they have become merely milk-depots, with a decided tendency to "half skim," and sell cream, then sending the partly skimmed residue to market as whole milk. This procedure increases the surplus, lowers the standard, and demoralizes the trade, doing exactly what the creameries were originally organized to prevent. This is no argument against coöperation in the milk business, but should serve as a warning against abusing a system good in itself.

The best example of a proprietary establishment of this kind in the country is what is known as "The Alderney Dairy" in the city of Washington. Its owner, Frank K. Ward, began on a small scale, peddling milk from a few cows of his own, but soon saw that the business was one which promised profit only by being conducted on a large scale, and with great system and economy. He bought out routes, made contracts with producers, and gradually enlarged his operations until he possesses one of the largest milk-depots in America, and

almost monopolizes the best trade of the city of Washington in milk and its products. No amount of surplus annoys him, as the capacity of the Alderney Dairy is ample for storage, and for making butter and cheese. His business is now so thoroughly systematized as to be conducted upon very small margins, and he is enabled to supply consumers at very moderate rates, while at the same time he pays the producers more than they can elsewhere obtain in that vicinity. This establishment has many interesting features, and is in its way a model.

In the general system of city supply, on the largest scale, there is ample room for coöperation. In this case, both producers and consumers should be included. Their interests are mutual, and they should be brought into harmonious and profitable relations. It is unquestionably practicable to entirely do away with the middle men who are such a load upon the business of city milk supply. Of course the expenses in conveying the milk from the farm to the family cannot be avoided; but the *profits* now obtained by contractors, wholesale and retail dealers, can be pooled and divided between producer and consumer. Let us suppose the producer gets four cents per quart, and the consumer pays eight cents. If by joint action the four cents margin between them can be reduced to two cents, which I believe possible, there will still remain two cents to divide,—the farmer will get five cents instead of four, and the family pay seven instead of eight. Or even if one cent a quart only can be saved for such division, it is well worth the effort. To the farmer this would be ten or twelve dollars per head annual profit on every cow. But judicious coöperation will double this amount, and yield at least twenty dollars per head to the cow owners, over and above their receipts under the present system.

This is not individual opinion. Examples can be given of successful enterprises of this kind. I might describe to you the great coöperative dairying establishments of English cities, and large concerns like the Aylesbury Dairy Co., of the West End of London, and the Holland Park Dairy at Kensington. But there is no need of going out of our own country for proof of the benefits of coöperation in the business of producing and

selling milk. There is an establishment which has been in successful operation in Syracuse, N. Y., for more than ten years, and it is simply a marvel to me that this is not better known, and that its results have not led to the formation of many others, before this time.

THE ONONDAGA COUNTY MILK ASSOCIATION OF SYRACUSE, N. Y.

This corporation was chartered and began business early in the year 1872. The capital stock was originally $25,000, but it has been a steadily prosperous concern, and has since increased its capital fourfold. The stock is held by about sixty persons who were formerly milk producers, and dealers acting independently, and it is apportioned at the rate of twenty dollars to each cow usually kept in milk by the holder: the stock-book shows that the members own from seven to seventy cows each. The head-quarters of the association are in the city, where it owns and occupies a large four-story brick building provided with every accommodation for receiving, keeping, handling, and distributing milk, for manufacture of all milk products, for boarding and lodging the thirty or more employés, and for general business purposes. There are offices, the directors' room, and a well-arranged hall for meetings and discussions by members of the association and other dairymen. In the rear are barns and stables for twenty-five horses, sheds for as many wagons, sleighs, harnesses, etc.; also, a repair shop, a blacksmith shop, and other conveniences. The association maintains twenty milk routes, with a wagon and peddler upon each, supplying about 40,000 people through the year. Thus one wagon serves 2,000 persons, or about 400 families. The management is delegated to a president, vice-president, and nine directors, of whom five form the executive board, and the working force comprises a superintendent, cashier, and accountant, milk-receiver, two distributing clerks, cheese-maker, hostler, blacksmith and helper, housekeeper and assistant, and twenty peddlers. All the help is boarded at the building of the company, and one of the most interesting items in connection with the enterprise is the fact that board satisfactory to the employés has been furnished at a cost of less than ten dollars a month.

The association originated from a prosaic desire on the part of milk producers to benefit themselves, and a belief that several persons who were selling milk in Syracuse, each one by himself, could economize in labor and cost of delivery by coöperation. The object was to establish a central depot, where the milk produced by all could be received, thence distributed, so far as it could be used as milk, and provision made for working the surplus into butter and cheese, on joint account. The great saving expected was in the delivery to consumers. It was thought that instead of half-a-dozen wagons running daily through the same streets, to furnish here and there a family, as occurs often under the usual system, the customers of the six peddlers might, by union of interests, be supplied from a single wagon. Next was the expected saving by advantageous use of the surplus milk,—that of several peddlers being "pooled" or handled in one mass. Both of these expectations have been so far realized as to give prosperity to the association. The independent "owners" of milk routes at first looked with suspicion upon the concern, but one by one have found it to their interest to join. The impression of a monopoly, likely to be at first formed, is not sustained by the facts, for the association has opposition enough from individual sources to force it to keep down its prices and keep up the quality of its milk. The result has really been to maintain in Syracuse a high standard of quality, and very reasonable rates.

Every member of the association has a business interest in having everything right, and giving the public full satisfaction. This leads them to sustain the management in making and enforcing strict regulations to insure cleanliness, purity, and a good quality of product, and to ferret out any fraud and bring offenders to justice. Frequent tests are made of milk received, and close investigation as to causes follow all appearances of inferior quality or any irregularity. The directors often employ inspectors who are strangers to the producing members whose farms they visit, and their reports, covering the most minute particulars, are only made known to the officers of the association.

These interesting facts are derived from the annual reports

of the association: There is the greatest consumption at the season of greatest production. The winter demand is somewhat reduced by the increase in retail price. Five cents in summer, and six in winter, has been the rule at Syracuse. The shrinkage or total loss in measuring, spilling, changing, and cleaning cans amounts to 9 per cent. on the total business, and to 12½ per cent. on the delivery routes; in all, the association loses annually in this "shrinkage" the whole milk product of 120 cows. The total expenses average *less than one cent* a quart on the milk sold, and 84 cents for every 100 quarts of all the milk handled. This shows what is possible in the way of reducing the cost of city supply.

Fifty-two dairies contributed the milk of about 1,600 cows. The actual average product of the cows was 6.52 quarts per day, or 2,380 quarts per year—a very creditable showing. One owner of ten cows attained an average of 3,766 quarts per cow and year, and one owning 40 cows averaged 3,339 quarts. The lowest average of any member was 1,843 quarts.

Referring again to the relation of milk sales and soil fertility, attention is invited to the tables already presented. While it is seen that 1,000 pounds of milk contain nitrogen, phosphoric acid, and potash, worth $1.54, the second table shows that of these elements seven eighths are held by the skim-milk (value $1.34½), while in the cream there are only enough to be worth 19½ cents. Hence, in selling the cream alone, from a standard cow, the manurial loss for a year would amount to but 92 cents instead of $7.50, where the whole milk is sold. But under the cream-gathering plan, every patron of a factory may take home his share of the buttermilk. Look at the table once more. Of the 19½ cents' worth of fertilizing material in the cream from 1,000 pounds of milk, 18¼ cents' worth remain in the buttermilk, and only 1¼ cents' worth go with the butter. Selling all the butter from a good cow will draw upon the fertility of the farm in the course of a year to the extent of just about six cents. Here is the first and not the least of the advantages of contributing to a cream-gathering butter factory, and using the skim-milk and buttermilk on the farm.

Three years ago it was stated as *probable*, and by many ridiculed, that the factory product from the cows of a whole community might be made to equal in quality that of the best single dairies in the town; and, further, that the factory would make full as much butter from the same cows as could be done on the farm. Both of these expectations have been realized by the cream-gathering factories in this vicinity. According to the statements of local consumers, and the still severer test of the general market, no better butter is made in Hatfield and Easthampton than that of the factories in those towns. And I have the testimony of several farmers who send their cream to the factories, that the latter make even more butter per cow than could be done at home. One patron says that the gain in his case has been at least ten per cent.

The increase in the average quality raises the price, so that enough more is obtained to pay the factory expenses. During the present year the average price of creamery butter in the large cities of the East has been 34⅞ cents per pound for the very highest grade known to the wholesale trade. The average selling price of the product of the Hatfield creamery for the year has been 34⅛ cents, and for the Hampton creamery 35 cents. During the same period the average for the best dairy butter has been less than 30 cents. The Hatfield creamery, by close management, has kept its expenses down to 3½ cents a pound, and thus netted its patrons for every 114 cubic inches of cream (not quite two quarts), something over 30 cents, or more than the average price of home-made butter. In Easthampton, the effect of sending creamery butter from town, several thousand pounds a month, has been to create a scarcity in the local market, and keep the price of dairy butter higher than ever known there before. In this instance, the cow owners not contributing to the factory have been benefited by its existence almost as much as the patrons themselves.

The general effect of this kind of factory has been to produce as much money revenue from a given number of cows as ever before, while the cow owners and their families have been saved all the time, labor, and annoyance of making and marketing the butter.

As nearly as can be ascertained, the patrons of these new factories have obtained for the cream of their milk, skimmed and removed by the factory agents, almost three cents to every quart of milk, being nearly if not quite as much as obtained on the average by the producers of whole milk, who have sold it, in this state. Besides this, with no more labor than in the case of milk selling, the factory patrons have had all their skim-milk left sweet upon their farms. Judiciously used, this is worth at least a cent a quart more. I believe, from all I can learn, that those farmers who have during the present year sent their cream to Fairlamb butter-factories in Massachusetts, have netted just about four cents a quart for their whole milk produce, with a minimum of dairy labor.

One important point is as to the equity of the system among the different cow owners contributing to a factory. How does the owner of the best of butter-stock, well kept, compare with his neighbor who has inferior cattle? Perfection is not claimed for the system, but it certainly comes nearer to perfect equity among the patrons of a factory than any other known. With the better cows and better care more cream is obtained, and thus more money. The good stock has a much greater advantage than in any existing system of selling milk, where, in the general market, if not so poor as to be wholly rejected, the produce of one dairy stands on a par with all others. There is but one qualification necessary; owners of really inferior stock, and neglectful at that, will reduce the average of the factory both in quantity and quality. The cream from such farms should be absolutely rejected.

The testimony is uniform, that the effect of substituting the Fairlamb plan for the old system of home butter-making has been a wonderful relief to the farm household. On any farm where milk selling has taken the place of butter-making, this relief can be fully appreciated. This cream-gathering butter-factory system affords precisely the same benefits in saving domestic labor. In short, wherever a creamery of this kind has been established, it is pronounced a blessing to the community.

If you are making milk, anxious to sell it, and have to depend upon a limited market, don't go into competition and

ruinous rates, but join your neighbors in maintaining a fair scale of prices.

If living near any place which consumes the milk of 500 cows or more, do not let the season pass without leading in a coöperative movement for a dairy or depot for joint delivery and general distribution.

If you are shipping milk to a distance, especially to Boston, join at once in putting the Massachusetts Dairy Company, and others like it, into active and successful operation.

If producing milk, but still wisely declining to sell the whole article unless you can get five or six cents a quart for it, a believer in skim-milk and buttermilk as economical food for all kinds of live creatures on the farm, and also anxious to be rid of home butter-making, help to start a factory in your neighborhood on the cream-gathering plan. Don't hold back to see how it will work, and, above all, do not hesitate because it may help others more than you, as is quite likely. The man who will refuse to benefit himself and his family from fear of helping others, and the one who remains inactive waiting for others to do work which will benefit him, must both be near akin to the individual who is said to have bitten off his own nose to spite his face.

In short, if interested in the milk question, be not content to let things remain in their present unsatisfactory state. Be active and earnest. Organize! organize! *Do* something, when so many ways are open. It is work, and not growling,—*work* for your own interests and those of your fellows,—that is needed to settle the milk question.

CREAMERIES.

DISCUSSED BY THE HILLSBOROUGH COUNTY COUNCIL.

REPORTED BY KIMBALL WEBSTER, OF HUDSON.

John Fletcher, of Greenfield. If creameries can be established and managed by experienced and competent parties, so as to shun labor in producing a good quality of butter, and open a new channel for milk in opposition to the Boston market, I think the investment will pay. Farmers would get a better price for milk. Cows should be carefully managed, and kept warm. They are liable to take cold.

Gardner Blanchard, of Wilton, said he could see no reason why a creamery would not succeed.

Mr. Foster, of Wilton. Have sold milk for more than twenty years, and it has been a query whether it is profitable. I have studied the creamery question, and the question of location, where it would best accommodate the producers. Under good management I think they would get more for their milk than at present. Butter-making at home is out of the question with me, but with a creamery all can share alike. The cream only would be taken, and each would have credit for the amount furnished, and save all the milk to be used on the farm. A high and uniform quality of butter would be made. I hope the time is near when it will be accomplished. It would regulate the price of milk, and benefit all producers.

J. N. Dodge, of Peterborough. A creamery would require about $3,000 capital, and 600 cows to supply it with cream. The butter would command a higher price than the average, but no more than such as is made by Mrs. Day, of Peterborough, and

some others. The question depends much upon location and management. Cream varies in weight, and if manufactured at home we have our own cream and the skim-milk. To succeed in making butter it is very essential to have good cows. I test the milk of each cow two or three times a year. By putting it in a goblet, and looking through it, I can tell good milk for butter. I have a good butter-maker at home, and shall contrive to make my own butter as long as I am able. Good sweet butter cannot be made from poor feed, but if colored so as to look attractive, it will sell. Good cows will make twice the amount of butter, and the expense of keeping is but a trifle more than poor cows. To insure success, everything must be well done.

G. F. Day, of Peterborough. A pound of butter can be produced at a less cost than a pound of beef. In twenty-three days, commencing the first of January, I made one hundred and fifty-two pounds of butter, which sold for $56.24 net, delivered at the express office. The grain fed cost $20.24, leaving $36 for hay and profits. I have ten cows, all young including three two-year olds, and three came in last spring. The average is about a pound of butter to a can of milk. Set milk in deep cans thirty-six hours. The butter will not come quite as readily as by the old system. It is an unsettled question whether cream should stand to ripen, or be churned when sweet. Artificial coloring will not sell poor butter in the Boston market, but it must stand on its merits. The milk of each cow should be tested frequently; and if one is found to be poor for butter she should be disposed of at once. To test it, I use fruit-jars set in ice-water, and let it remain till the cream rises, when the percentage can be easily ascertained. It will not pay to keep twelve or fifteen cows, and get a little income from them in summer and spend it all to winter them. We should do something—either start a creamery or something else. For butter, I feed two parts cotton seed, two of corn meal ground in the ear, and two of shorts. Cotton seed is good for milk or butter.

W. W. Howard, of Milford, said the milk business was overdone, and contractors buy it at their own price.

Mr. Follett, of Temple. To start a creamery will require a large outlay, and it would require time to establish a reputation so as to be able to sell the butter at the highest price. It is

hard work for a woman to make butter; but we must do something to get some money. I sell milk, and we are obliged to sell at just such price as the contractor chooses to pay. I think we should have a creamery in each town. Thirty farmers can furnish $100 each, and make up the necessary capital of $3,000. The farmers in Iowa are receiving a larger price for their milk furnished to the creameries than Whiting is paying in this valley. It pays to keep cows well. It costs me two fifths of the value of the milk to pay for grain.

Mr. Dodge said a cheese-factory should be connected with the creamery so as to convert the milk into cheese; that we were buying skim-milk cheese, colored, from the Vermont creameries.

D. W. Burnham, of Greenfield. Farmers should educate themselves so that they may know what is for their interest, and what will pay them best. Their situations and surroundings are so different that what will pay in one instance may not pay in another. A creamery will pay some, others will do better to sell milk, and others to raise beef.

William Moore, of Peterborough. The cost of the grain I feed is more than the value of the increase in the milk. It does not pay to feed out a large quantity of hay in winter and receive no income from it. If a farmer pays $30 for grain, and it increases the value of the milk $24, he is making money in the way of increasing the productive capacity of his farm.

Mr. Goodhue, of Hancock, said the question was a very interesting one, and he believed a creamery would be of great benefit to the farmers.

Henry Gray, of Wilton, read a communication from Hatfield, Mass., in relation to a creamery in successful operation at that place. He said the best grade of creamery butter was selling at 47 cents, and the best dairy at 41 cents.

B. F. Hutchinson read an article giving interesting statistics in relation to a cheese factory in Hamilton, Me. He said contractors are making large profits on milk. They fix the price, and the producers are obliged to accept it. If we could sell all the milk to go to Boston, perhaps we could do no better; but there is a surplus which causes a cut down in price. Some choose to keep the surplus at home; others prefer to have Whiting work it up at his creamery. He continues to increase his

business, and has put on a milk car to Peterborough. He makes a profit to ship it. The surplus is made into butter; and why may not producers manufacture it themselves at a profit over the selling price, if they provide proper facilities for the purpose? I believe butter or cheese factories would pay the farmers of the Souhegan valley, and especially those far from railroads. Mr. Whiting raised last year about $1,500 worth of pork with little expense outside of skim-milk from his creamery.

J. U. Prince, of Amherst, said the plan practised in Hatfield, Mass., where a man collects the cream for the factory, leaving each producer his own milk, is a good one. It would, I think, be expedient to establish a creamery in Amherst. The market demands creamery butter, and whatever is so demanded will be produced. Very few milk producers are so situated as to be able to manufacture butter, and it is impossible to hire suitable help to make a first class article. The creamery system is only a question of time. It will be adopted. Other states have had butter and cheese factories, but there are very few in New Hampshire. It is about the last state to adopt new measures. We may coöperate in this matter to better advantage than in almost any other direction, and hope it will soon be done.

Hon. W. T. Parker said, How can milk be disposed of to the greatest profit to farmers? Can we antagonize the present system? We cannot. If we take our milk to Boston, we must furnish teams, etc., and distribute it to many thousands; but in the creamery it would all go to one place. To carry it to Boston and antagonize the present contractors would bring down the price. We don't want to carry more milk there, but create a new channel, a new avenue, for our surplus milk, and we increase the price. Our help is not sufficient to manufacture it at home, and suitable skilled help cannot be had, and necessity compels us to go into the creamery system. Basing my judgment on market quotations, creameries can compete with the best home-made butter. It is an interesting fact that creamery butter is the best,—far above the average. Large quantities of poor butter are shipped to Europe. I defy any man to hire ten women who can make good butter; it is an impossibility. There is a deficiency of skilled labor, and I believe the only successful outlet for our surplus milk is the creamery.

R. M. Rollins, of Bedford. I think Brother Parker has struck the key-note. A very large amount of milk is produced in this country. A few years ago Vermont butter was quoted at the highest; now the Western creamery takes the lead. Iowa is a large dairy state, and has two hundred and fifty creameries in successful operation. The creamery butter is of uniform quality: hence its popularity and market value. Many women make as good butter, but it is less uniform, and cannot compete with the creamery. The cans used by creameries are uniform in size, and have a scale on the side graded to inches and fractions. An inch of cream will make a pound of butter. The cream is collected, and the milk kept at home. It is impossible to get help to make butter at home, but a man and his wife may be had to manage a creamery.

Mr. Kittredge, of Merrimack, said he thought a creamery would be beneficial to the farmers, yet it would have a tendency to reduce the price of butter. If all the producers in the Souhegan valley would demand a fair price for milk, and stick to it, they would get it.

Hon. W. T. Parker. There has been a new channel opened to reduce the price of milk in this valley. The cooling system has been introduced, and arrangements are being made to bring it from Stoddard and other back towns, and the result will be that every producer who does not sell to the contractor will be cut off.

B. F. Hutchinson. I have been informed by the contractor that milk brought from back towns will not work to our disadvantage. They would like to have the quantity reduced at times. Contractors have formed an association in Boston by which milk may be supplied from one route as well as another: they have consolidated. Another important fact connected with selling milk is, that fertilizers must be supplied in some form to maintain the productive capacity of the farm. We see many farms a little back, with buildings neglected and gone to decay, and fields and pastures once productive grown to bushes. These may be reclaimed, and restored in a measure to their former condition by the creamery system. I don't think there is any danger of overstocking the market with good butter.

Oliver Dodge, of Nashua, said he was not very much inter-

ested in milk or butter, but thought creameries for farmers situated remote from market would be very beneficial.

Alpheus Swallow, of Dunstable. Have made butter for thirty years, and kept from six to ten cows. Have two sons employed in a creamery, where they make from eight hundred to one thousand pounds of butter a week without any female labor. Last year I tried the experiment of a small creamery at home, and it has proved successful. I used two cans about the size of milk-cans, and about twice as high, which hold about fifteen quarts each. They are placed in ice water, and the cream will rise in eight or ten hours. I use the Stoddard revolving churn and a butter-worker. Commenced selling butter in Boston last spring, at 28 cents, but for the last two months have sold for 40 cents. The expense of the creamery arrangement did not exceed $25, aside from my own labor. The milk stands from one milking to the next, and only two cans are needed for a small dairy. Butter cannot be made of a good quality at all seasons by the old system. We get as large a quantity, and a better average quality. I would not in the least discourage the creamery system, but think farmers situated remote from such conveniences may use a small creamery of their own to good advantage.

S. L. G. French, of Nashua. I believe in the creamery. Competition is what we need, and it is a wise plan to open another channel for our milk. One reason why women cannot make as good butter as is made at the creamery is, that they have no good place to keep the milk. It should be immediately cooled, and in the absence of ice, cool running water will answer as well, or perhaps better. The creamery will work up the surplus milk, and increase the price.

C. C. Shaw, of Milford. We should organize and establish creameries. System and regularity are required in butter-making. Very few farmers have a suitable place to set the milk. Good cows must be kept, and much care used in feeding. I sold a cow that is now producing nearly three pounds a day. I have sold butter at 75 cents a pound. A man a short distance out of Boston was selling at $1, and another man in New York at $1.25. Turnips and cabbages cannot be fed to cows without tainting the milk and butter.

Walter Kittredge, of Merrimack, said he had visited several

butter and cheese factories, and if he had a farm he would favor a creamery.

Ward Parker, of Merrimack. The cause of the low price of milk is, that the market has been overstocked. The quantity crowded upon the market should be reduced. I don't think a creamery established on the coöperative system would succeed. It must be done by individuals.

J. H. Woodward, of Hudson, said he thought a creamery, if properly managed, would pay.

THE SILO AND ENSILAGE.*

BY B. P. WARE, OF MASSACHUSETTS.

The system of preserving grain, fruits, and forage in subterranean vaults, in its green state, is spoken of by the earliest writers as being commonly practised by the ancient Romans, and has been practised by the Mexicans for centuries. In France, Germany, and other countries of Europe, green crops of all kinds have been buried in pits for preservation for more than fifty years, with more or less success. But to M. Auguste Goffart, a distinguished member of the Central Agricultural Society of France, belongs the honor of having perfected the system of preserving in silos, for an indefinite time, all green forage crops, substantially in their natural condition, for food for all kinds of farm stock.

He began his experiments in 1850, but was only able to preserve his green fodder for three or four weeks, until 1873, when he had better success. Not until 1876 did he discover the necessity of continuous pressure, by which only can complete success be secured.

Goffart published his whole experience to the world, and in 1879 J. M. Brown, Esq., of New York, translated and published his work, giving to the farmers of the United States reliable information upon this method, that is rapidly producing an entire change in the system of agriculture in this country.

To Mr. J. M. Brown, as well as to M. Auguste Goffart, do many of our most prominent farmers, who have adopted it, acknowledge a debt of gratitude.

In 1873 Francis M. Appleton, of Lynnfield, Essex county, while making a tour in Europe, was shown in Hungary the

* Given at farmers' meeting in Manchester.

method of burying green corn-fodder in pits, to make what they called sour hay. Although much waste resulted from this method, and the contents of the pit opened in what would now be considered bad condition, it proved a wholesome food for cattle, and an economical system of preserving the fodder. Mr. Appleton obtained from his Hungarian friend a description of it, for publication in this country, which appeared in the *American Agriculturist* for October, 1873. Mr. Appleton copied it into his essay on Foreign Agricultural Experience, which was published in the Transactions of the Essex Agricultural Society for 1873.

This is believed to be the first information published in this country on the subject of ensilage. In 1875 Mr. C. W. Mills, of New Jersey, buried a large quantity of white dent corn, which had grown to an enormous size but failed to mature its ears, in large pits under five feet of earth, for the purpose of getting it out of sight. In the spring, instead of finding a manure heap, he discovered an immense quantity of valuable food for his cows, that they liked better than any other fodder. He thus early by accident discovered, without any previous knowledge of it, the process of ensilage, and has since made a complete success of it.

Mr. Francis Morris, of Maryland, in 1876 first filled brick silos on a large scale with tolerable success. John M. Bailey, Esq., of Billerica, Mass., was the first man in New England who dared to build and fill a silo after the instructions of A. Goffart, and take the chances of loss in the investment, the ridicule and obloquy of his neighbors and the community at large in case of failure, or of pecuniary advantage with the honor and respect of all progressive farmers if successful. I believe he is eminently satisfied with the results after three years' experience.

There can be no doubt but that good farming must be based upon cattle, sheep, and swine. But each individual farmer must decide for himself whether it is best for him to keep farm stock, taking into consideration his location and the kind of farming most profitable for him.

But for him who does keep live farm stock the question, How shall it be fed at the least cost and to be kept in the best condition? is a very serious one, especially in New England, with its

hard and comparatively barren soil and severe winters. While grass is crowned king, corn must be acknowledged queen, of the forage crops. Clover, rye, oats, barley, and the several millets may be supplemented to advantage, but the principal dependence must be upon the two first named.

The great question of to-day among farmers is, How shall the greatest amount of nutritious ingredients of the forage plants be preserved at the least cost?

Fermentation, that tends to decomposition or putrefaction, requires the presence of heat, air, and moisture;—the elimination of either one of these conditions will prevent fermentation. By dessication, hay is preserved by removing the moisture, while air and heat remain By the absence of heat, as in cold storage, air and moisture remaining, decomposition is checked; and, by the exclusion of air, heat and moisture remaining, the same result is obtained. Chemistry teaches that no valuable nutritive qualities of grass or other green forage plants are lost by drying. It also teaches that by the cutting of any green or living plant and slight exposure to the air, a molecular action sets in, which converts the starch and sugar of the plant into lactic acid. The oxygen of the air does not enter into this action, and the chemical constituents of the substance remain as before, the same quantities of the same elements, but in different combination. But this change *does* affect the feeding value of the substance to a considerable degree, so that in putting ensilage into the silo under the best conditions that the farmer can provide, a loss of feeding value of from twenty to twenty-five per cent. must inevitably occur. Under less favorable conditions, as when the air is less fully expelled from the ensilage, alcoholic fermentation takes place, from which, as further oxidation goes on, acetic acid is produced. Then at least fifty per cent. of the feeding value is lost.

Chemists, however, admit that possibly the formation of lactic acid to a certain amount in the ensilage may, in the absence of air, act as an antiseptic, and thus check further decomposition; and, also, that this acid, being a normal constituent of the contents of some of the digestive organs of animals, may render the ensilage more fully digestible, and thereby increase its value to some undetermined extent.

It does thus appear that the chemistry of ensilage is certainly very much against this method of preserving green forage. Chemists, and most of those persons who have had no experience in feeding ensilage, are opposed to this system as being costly and wasteful. But hundreds of careful, observing farmers, who have had from one to five years' experience in its use, to a man pronounce it the most economical aud profitable method of preserving and feeding green crops to all farm live-stock, and especially for dairy products and growing animals.

This wide difference of opinion may perhaps be reasonably accounted for by the fact that the chemist deals in his laboratory entirely with dead matter, while the farmer deals with life in the food and life of animals. The chemistry of life and the chemistry of death may differ as much as the difference in opinion that exists between the chemist and the farmer upon this subject. For instance: to the farmer fresh June grass appears to be a complete food for farm live-stock, producing the greatest growth in young stock, and the sweetest, yellowest butter in the dairy. The chemist finds no difference between the grass and the hay made from it, perhaps because he makes hay of it before his analysis, although it is found to lack a proper proportion of protein for a complete food; that butter made from it is of indifferent flavor and lacks color; and that it produces less growth and less quantity of milk. The same difference in results appears between the feeding of ensilage, and the same material fed after being preserved by drying.

Now as these stubborn facts that have been developed by the feeding of ensilage during the past few years will not adapt themselves to the theory established by chemists in the laboratory, would it not be well for the chemist to pause, and endeavor to find reasons that will bear the test of chemical investigation for these well established facts so much at variance with the present development of the laboratory, and promulgate a theory more in accordance therewith?

No one can appreciate more than the writer the benefits that agriculture has derived from chemistry during the last fifty years, or is more anxious that this decrepancy should be cleared up and explained;—for farmers have learned to look to the science of chemistry to unravel many mysteries, and remove many obstacles that now block progress in the art of farming.

Below are given the analyses of two lots of corn at the time they were cut green for ensilage, and again two months and a half after being put in the silo. The analyses were made at the Massachusetts Agricultural Experiment Station at Amherst.

Lot No. I was cut when in full tassel and ears just forming, showing silk but no grain.

Lot No. II was cut before any tassels appeared.

Both lots were cut when in vigorous growth.

I.

	From three feet below surface.		
	Green corn for ensilage.	Corn ensilage.	
Moisture,	84.880	84.125—difference,	.755
Dry matter,	15.120	15.878—difference,	.755
Ash constituents,	1.041	1.156—gain,	11.066
Crude cellulose,	4.684	6.003—gain,	25.216
Fat (ether abstract),	.109	.363—gain,	232.844
Carbo-hydrates, non-nitrogenous extract matter,	8.054	7.045—loss,	12.521
Protein, nitrogenous matter,	1.233	1.307—gain,	5.912

II.

	From two feet below surface.		
	Green corn for ensilage.	Ensilage.	
Moisture,	87.974	87.882—difference,	.091
Dry matter,	12.026	12.117—difference,	.091
Ash constituents,	1.155	1.054—loss,	8.744
Crude cellulose,	4.037	4.035—loss,	.0447
Fat (ether abstract),	.233	.306—gain,	31.712
Carbo-hydrate, non-nitrogenous extract matter,	5.299	5.469—gain,	3.2
Protein, nitrogenous matter,	1.302	1.254—loss,	3.664

A bag of corn from lot No. I, cut for ensilage, was placed in the silo with the ensilage, nine feet below the surface. The bag was moistened sufficiently to prevent its absorbing moisture from the ensilage. It then weighed thirty-two pounds, and on being taken out four months afterwards showed precisely the same weight.

In response to a circular letter of inquiry for full statements

of results of experience in building silos and feeding ensilage, which was issued June 10, 1882, by the commissioner of the Department of Agriculture at Washington, answers were received from sixty-nine prominent farmers located in different parts of this country and Canada. In every instance they were favorable to ensilage as a profitable method of preserving green fodder.

From a summary of these replies, and from my own experience, the following facts and recommendations are given:

The silo should be located near where the ensilage is to be fed, but separated from the live-stock, especially where cows are milked, so that no gaseous emanations from the silo can affect the flavor of the milk by their odors, which has in a few instances occurred. A parallelogram is the best form for a silo. It should be partly underground, with solid concrete or stone walls, smoothly cemented and made impervious to water. The part that is above ground may be of wood, with strong frame to support the lateral pressure, and ceiled with planed, matched boards, one thickness being sufficient. The deeper the silo the better, up to thirty feet. The covering should be of plank, or of battened boards, from two to four feet wide, laid directly upon the ensilage, allowing space for settling, without pressure against the sides of the silo. This covering must be weighted with any heavy material most convenient. Nothing is better than stones that a man can conveniently handle. A pressure of two hundred pounds to the square foot is requisite for good results. The cost of building walls of masonry is from three dollars and a half to five dollars per ton of capacity, and fifty cents or less for wooden structures.

While corn takes the lead as a crop for ensilage, any other crop used for soiling cattle makes good ensilage. The varieties of corn making the largest growth, such as the Southern White, or Blunt's Prolific, give the best results. With good fertilization and cultivation, from twelve to fifty tons may be grown on an acre, according to circumstances. From twenty to twenty-five tons may be considered an average crop. Cultivation with the Thomas smoothing harrow until the corn is eight inches high, and with a horse-cultivator once later, is sufficient: no hand hoeing is required.

The average total cost of raising and filling the crop into the silo, as taken from the accounts kept by fourteen growers, is two dollars and sixty-three cents per ton. The cost varied from ninety-two cents in Nebraska, to four dollars in Lawrence and North Andover, Mass.

The best stage of growth to cut ensilage is when the grain is in milk. Three pecks or a bushel of seed to the acre, sown in drills, from three and one half to four feet apart, has given the best general satisfaction.

The usual practice has been to cut the fodder for ensilage three eighths or one half inch long, and to tramp it thoroughly; but inasmuch as the breaking or cutting the cellular structure of the plant produces molecular fermentation, it would seem the less cutting and mashing of the cells of the plant there is by treading (consistent with proper levelling) the better; and it is found that with sufficient weighting (two hundred pounds to the square foot), cutting an inch or an inch and a half long gives better results by producing less fermentation, and hence better quality of ensilage. The experience of the past year has enabled farmers to control fermentation in the silo better than ever before: hence the ensilage is generally less acid. Ensilage has been kept two or more years in the silo in good condition, and it is not in its best condition until it has had at least two months' curing in the silo.

An ordinary sized cow will eat on an average sixty pounds of ensilage per day, which should be fed in two rations, morning and evening. Corn ensilage is not considered a complete food, as it does not contain protein, carbo-hydrates, and fat in proper proportions—protein and fat being deficient for an economical feeding standard. This lack should be made up with articles rich in these ingredients, such as cotton-seed or Indian meal. It should be considered as a substitute for hay and roots, but not for grain. All kinds of farm live-stock eat it with avidity, when fed as a substitute for hay and roots. They thrive better, and yield an increase in milk and flesh from nine to twenty per cent. more than when fed on good hay,—the milk, butter, and flesh produced from it being of superior quality, resembling that from June grass, and the cost of feeding stock with it is less than one half that of hay, when valued at twenty dollars per

ton. It has been proved that cattle fed upon it year after year continue in thrift and health.

Many have claimed that two tons of good ensilage was worth as much as one ton of English hay, but by a carefully conducted experiment it proved that with hay at twenty dollars per ton, a ton of corn ensilage was worth for producing milk and flesh seven dollars and twenty-six cents, making two and three fourths tons equal in value to one ton of hay.

It requires a good five- or six-horse power steam-engine to run a twenty-inch cutter effectively. With such power a large horse-load of corn was cut one and one half inches long in five minutes repeatedly last season, but nine minutes was the usual time occupied. A two-horse tread-mill will do good work with such a cutter. John G. Walcott, of Peabody, filled silos in Essex county last season with a portable six-horse engine and twenty-inch cutter for seventy-five cents per ton, the corn being delivered to the cutter from the field. This is a practical way of avoiding the objection of each farmer's going to the expense of running the necessary machinery. At a convention of farmers and others interested in ensilage from different parts of the country, held at New York in January of 1882, after full discussion, the following resolution was adopted:

Resolved, That it has become a well-established fact, after six years' successful use in this country, and by the concurrent testimony of many intelligent farmers, that the ensilage system is of great advantage to the farming interest, as well as to all mankind.

One year later, after another year's experience, a similar convention was held at the same place for the same purpose. The following resolution was adopted:

Resolved, That the Ensilage Congress, assembled in New York January 25, 1883, desire to express to M. Auguste Goffart, of France, their appreciation of the great value of the system of ensilage discovered and introduced by him. They recommend to the farmers of the United States its universal adoption, as the cheapest and best method of preserving fodder-crops.

In order to show the cost of growing ensilage corn and putting it into the silo, and what may be considered a good method of conducting the system, and also what may be expected as

the results from good land under ordinary circumstances, I will give in detail my account with a three-acre lot that had been in pasture for ten years, the planting of which was finished June 28, 1882.

DR.

To breaking up with pair of horses and side-hill plow three acres at $5,	$15.00	
harrowing thoroughly with spring-tooth harrow, two days, men and pair horses at $4,	8.00	
harrowing with fine harrow and brush, one half day, man and pair horses,	2.00	
planting with Ross's corn-planter by two men and one horse three fourths day, at $1.25 each,	2.81	
thirty cwt. of Ames's fertilizer, at $35 per ton,	52.50	
spreading the same broadcast, one man and horse one half day,	1.25	
three fourths bush. Southern white seed corn per acre, two and one fourth bush., at $1.50,	3.37	
July 12, harrowed over the whole with Thomas's smoothing harrow in two hours, corn four inches high,	1.00	
July 22, harrowed second time with same, corn eight inches high,	1.00	
July 29, cultivated thoroughly twice between the rows, two days, man and horse,	5.00	
Total,		$91.93
It will be noticed that the whole of the fertilizer is charged to crop.		
Oct. 10. Finished filling the silo with the following labor:		
Four men in the field cutting and loading the corn.		
Two horses and tip-carts with boy to drive to silo.		
Three men feeding the cutter.		
Two boys to shove the cut corn into the silo (this is an unusual charge, it being twelve feet off).		
One man to run the engine and level in the silo.		
Equal to 11½ men 3½ days filling at $1.25 each,	$50.30	
3½ days' use of machinery at $6,	21.00	
½ ton coal,	3.00	
		$74.30
Total cost of the ensilage in the silo,		$166.23

CR.

By two tons hay per acre, by estimate before plowing, six tons at $15, standing, ...		$90.00
thirty tons corn per acre, estimated on two acres,	60 tons	
twelve tons corn on one acre, estimated, which suffered badly by drought, ...	12 "	
	72 tons	
Value of ensilage compared with hay at $20 per ton, $7.26 × 72 =		522.72
Total value of products of the lot, ...		$612.72
Deduct total cost of ensilage in the silo, 72 tons at $2.32¼, .		166.23
Net value of product of the lot, ...		$446.49

THE AMERICAN TROTTING HORSE.

BY PROF. WM. H. BREWER, OF YALE COLLEGE.

[We know it is not popular to advocate or encourage the breeding of fast horses; that it is regarded as disreputable to defend the race-course. We do not see why it is more moral to allow a horse to travel only five miles an hour, than for one, under proper conditions, to go "inside of three minutes." There may be circumstances attending races, and often are, which are objectionable, and no one will condemn those surroundings more severely than the members of the Board of Agriculture. But that there is a source of enjoyment in the movements of a fleet and graceful horse, that there is a pleasure, a relief from pressing care, in a spirited contest on the race-course, but few will deny. We do not believe in the farmer's making an effort to breed and train track horses: we condemn it in general and in particular. As a rule, the farmer who undertakes it will suffer loss. Our advice is, to leave that business to professional breeders—to those who make a study and a business of breeding for specialties. They, if any one, have the knowledge requisite, which is wanting to a great majority of farmers.

It is important, now that we have superior trotters, to know something of their history, their relation to civilization and to the mechanic arts, as well as to the morals of this class of animals. This is given in a plain, direct, and attractive way in the lecture of Prof. Brewer, who has addressed New Hampshire people on the subject of breeding. Prof. Brewer is a man of scientific attainments, and is, at the same time, an exceedingly practical man. He has seen frontier life among the aborigines of the West, and is at ease in the refined circles of New Haven.

He always maintains his self-respect when smoking his cigar with horsemen on the trotting-park, as well as in the lecture-room of the Sheffield Scientific School, or in discussions with the learned men of our own or foreign lands.

Our farmers will be interested in the paper, and will be able to find it nowhere else. We copy it, without asking permission, from the Report of the Connecticut Board of Agriculture for 1882.—SECRETARY.]

The American trotting-horse is a very modern production. Our ancestors did not have the trotter, and what is more, did not want him. Why they did not want him, and consequently did not have him, how it has come about that we *do* want him and consequently have produced him, why he has been made, how he has been made, and what he is made of, is my subject.

As my audience is a mixed one, and not one of professional breeders, I will say on the start that I do not purpose to discuss the special blood or pedigree of any particular trotter or strain of trotters; that is the subject of an abundant literature, and to be of any use needs closer study than is possible in a popular lecture. My aim is more especially to portray the influences which have led to our breeding the trotter, and the rich results already attained. If I seem to ramble from the subject, remember that trotters themselves sometimes disappoint the spectators; and with lecturers as with trotters, they may start well, but break and fall behind on the course, and win no record.

The horse has been an essential factor in our civilization. What kind of a civilization we might have attained without horses I cannot say; but this much is certain, it would not and could not have been anything like that we now have. Moreover, the higher the enlightenment of a people, the greater the variety of uses to which horses are applied; and the American trotting-horse is a special product of the highest civilization the world has yet seen.

The horse first appears in history in Egypt. Lenormant dates his introduction into that country at the time of the "Shepherd kings," about 2,200 B. C., say about 4,100 years ago. The ass and other domestic animals are figured on the monuments much earlier. Among the Assyrians he also appears after the other domestic animals; and it was some 500 years after Egyptian

mention, and long after the ox, ass, sheep, and camel are spoken of, that the first allusion to him occurs in the Old Testament Scriptures, and the Hebrews probably did not use horses until Solomon's time. In Psalms the horse commonly appears only on the side of their enemies; and in a battle in the East, towards the Euphrates, where David captured the cavalry, he destroyed most of the horses, apparently because he could make no use of them (2 Sam. viii 4). It was some 300 years after Solomon's reign before the Greeks had cavalry, so historians tell us.

There are in existence a very large number of ancient representations of horses in statues, bas-reliefs, coins, engraved gems, and other works of art, so that we probably know pretty well what kind of an animal the horse of antiquity was. He was a small, strong, tough, muscular beast, but he was not a swift one in the modern sense. In a general way the relative fleetness and strength of different breeds of horses are indicated by their form, particularly by the angles which the bones of the legs form with those of the body. In those breeds noted for their fleetness the humerus forms a more acute angle with the shoulder-blade, and the femur with the pelvis and tibia, than in those breeds more specially noted for their strength. This gives the latter heavier necks and shoulders and more rounded buttocks than the swifter breeds have. This was the character of the horses of antiquity; this was the horse of ancient Greek art, and remains the horse of art even to this day.

I have examined all the ancient representations of horses within my reach for many years, and they abundantly show that however fond the ancients may have been of racing, their horses would have stood no chance with the race-horses of to-day. There is a difference between these ancient horses and those of the modern course almost as great as the difference between an ancient Greek or Roman chariot and a modern trotting sulky. A large portion of the celebrated frieze of the Parthenon is in England (known better as the Elgin marbles), on which there are over two hundred representations of horses. We have in the Art School of Yale college casts of the better portions of these bas-reliefs, and also other Greek representations of this animal. There are figures of twenty-eight horses: all date earlier than 300 B. C., and some are doubtless by Phidias himself, and rep-

resent the best days of Grecian art. They all represent small, tough, "wiry" breeds, all are dish-faced like the modern Oriental breeds, and all except one are roached. This is also essentially the character of the horses represented by ancient Egyptian, Assyrian, and Phœnician art. The art is often very rude, but the breeds represented are essentially the same type.

Of more interest in this connection are the attitudes of these ancient animals. Of the more than two hundred horses sculptured by Phidias on the famous frieze of the Parthenon, there is a great variety of attitudes, but not one is represented as trotting. Youatt, in speaking of these figures, says, "Only four are represented trotting, and these are wrongly made, in that both legs on the same side of the horse are raised at once." It seems to me much more probable that the old Greek sculptors were right; they studied their subjects faithfully, and most probably intended to represent ambling (or, as we say, *pacing)* horses. The horses of ancient sculpture are almost universally in this attitude, if not represented as rearing, galloping, or prancing. In the famous Cesnola collection in the Metropolitan Museum of Art in New York, the horses on the old sarcophagi, dating six or eight centuries B. C., are all in pacing attitudes. In the Museum of Fine Arts in Boston there are many Egyptian, Assyrian, Phœnician, Greek, and Roman representations of horses: none are trotting, but many are in ambling attitudes.

The same thing is shown on numerous coins and medallions to be found in collections. Modern artists have told us that this position, which I have called the ambling attitude (the two legs of the same side moving together, or in the same relative position if at rest), was a *mannerism* of ancient art. In a sense this is doubtless true, because other animals are sometimes (not always) shown in the same attitude; but it seems to me that this very mannerism was founded on the fact that in those early times trotters were despised, and ambling horses more or less used, and that the preferable animals were represented in art. When we remember that the ancients rode without stirrups, we need not wonder that they despised a trotter, and preferred a well-rounded, broad-backed, galloping or ambling animal.

The horse of art, from the earliest Egyptian and Assyrian sculptures down to the present century, was not a swift horse,

like either the modern runner or trotter. However much the individual animals differed, or even the breeds differed, the most prized animals as a whole were strong rather than swift, heavy for their height, with heavy necks, broad chests, and the well rounded buttocks we are all familiar with in the horses of art all down the ages, and which most artists still like to put in pictures or statues, but which we see in use chiefly hauling drays or express wagons. In that most popular of horse pictures, found in so many houses in the land, representing "Sheridan's Ride," doubtless made by an admirer of Greek art, we see the gallant general mounted on the broadest of cart horses, going at a rate that would wind him in two miles, and leave him drooping before he was the half of the "twenty miles away."

The horse is especially susceptible to the influence of surrounding conditions. When horses become wild and live as wild animals do, they develop naturally into native breeds, as instance the wild horses of South America, the mustangs of Mexico, the wild ponies of the Falkland Islands, and numerous other examples that might be cited. In domestication, surrounded by the various conditions which the artificial life imposes, and in obedience to the varied wants, uses, fashions, and sentiments of society, new breeds are moulded into shape until there is a vast number of breeds in existence differing from each other more widely than do the breeds of any other domestic species except dogs. It is not uncommon to see draft-horses ten and sometimes even twenty times as heavy as some Shetland ponies, and they differ in their endurance, temper, and instincts as much as they do in size and shape. Nearly every region has breeds, or at least strains, of its own, which have originated there, the special characteristics of which are in part owing to climate, soil, food, drink, or other natural conditions, and in part to man's directing care and his selection for particular qualities. Man's wants change; and what is of more importance in this connection, *fashions* change, and old breeds are modified, or new ones made to meet the new wants or satisfy the new fashions. The breed of race-horses known as the English Thoroughbred was made in the last century in obedience to special conditions, part natural and part social, and the trotter is another instance of this kind of evolution.

The American trotting-horse cannot yet be called a definite breed; it is rather a most instructive example of a breed in the process of formation,—a new breed just being moulded into shape by a curious combination of influences. To trot fast has not heretofore been natural to horses. We are in the act of making a breed in which it is the natural gait when at speed, and the next century will see a breed of trotters with two-minute horses as common as one minute fifty second runners now are. The breed is in process of evolution, in obedience to definite laws, to meet wants imposed by the new phases of our modern civilization.

Although applied to a great multitude of uses, down to a hundred years the horse has had its greatest value as an implement of war and ceremony. All other uses were subordinate to these. For these he was doubtless brought into Egypt; for these Solomon imported horses, and Greece, and Spain, and England; for these uses there are government establishments for breeding and improving horses in most European countries to-day.

Until artillery and baggage-wagon trains accompanied armies, the war-horse was emphatically a horse for riding. Chariots were sometimes seen, but their use was but as a trifle compared with the great use of the horses, which was to carry a rider or to carry a burden—that is, riding-horses and pack-horses. For this the best animal is one not too large; it must have strength, endurance, intelligence, courage, and if for riding, a variety of gaits. This last is a most desirable quality, that the change of gait may be a relief to both horse and rider on long marches. Any one who has had to ride by the hundred leagues on a stretch knows what that is. With this, as well as with pack-horses, I have had a feeling personal experience, having in one work ridden horse or mule over twelve thousand miles. This very week, an aged man, talking of his long business trips through the South sixty years ago, told me of an especially excellent horse "with four gaits." The horse of war and the horse of ceremony remained for ages essentially a *riding-horse*. For this use certain Oriental breeds have been noted from ancient time—the Persian, Arabian, Turkish, and the Barb—and their blood is mingled in various modern breeds, still constituting the best riding-horses in the world.

Besides their physical characters, their dispositions and instincts especially fit them for companionship with man. Between the *driver* sitting in a wagon, and the beast which hauls it along the road, there can be no such companionship and sympathy as between the *rider* and his horse. Each feels the every motion of the other; each knows the other's thought; the two seem as but one creature with a single brain and a single purpose. The centaur is a creature of the poet's imagination, but it comes very near a reality.

What an important *rôle* the riding-horse has played in the history of mankind can only be appreciated by a study of horses along with the nations. Take, for example, the history of Mohammedanism: Mohammed and his followers swept wherever the Arabian horse and his armed rider could tread, and no further. Other peoples had pushed their conquests by sea as well as by land; but by the horse and on the horse the Mohammedan conquests were made. The horse was the real standard-bearer of the crescent, and where the Oriental war-horse was stopped the spread of Mohammedanism was stayed.

The Moors went through Spain on their Barb horses; and when they were driven back, after several centuries of occupation, it was the men, not the horses, that went back. Their blood remained and made the Spanish horse the most noted of Europe, and what part they played in the wars of the times is the theme of many a Spanish ballad. When the Spanish horse was at its best, then Spain was at her height among nations; and as her horses declined her glory waned.

The Spanish adventurers brought their horses to America, and what part they played in the conquest of Peru and Mexico forms one of the most picturesque features of those cruel days. Those Spanish horses were the progenitors of the wild and half wild breeds which later spread from Patagonia and the plains of the Plata on the south to the West Indies on the east and the valleys of California on the north. The native Californian horses to this day show traces of their Barb origin through all the changes of form and vicissitudes of fortune, and of their riding qualities I have a vivid recollection of some thousands of miles upon them.

From Mexico the Indians of the plains derived their horses.

In earlier days dogs were the only beasts of burden with which the feeble tribes followed the buffalo in its migrations. The old Catholic fathers have told us what the Indians then were. Volney, an educated Frenchman, who made a trip in the far West in 1795 to 1798, has told us what they were even then. He compared those Western plains to Tartary, which he had also visited, and says "the likeness would be completed could we see its natives metamorphosed into horsemen," and adds that "this transformation has begun to take place within the last twenty-five or thirty years" among the Sioux, who were beginning to be mounted on Spanish horses derived from Mexico; and he prophesies that "in half a century more these new Tartars will probably become formidable neighbors, and the settlers beyond the Mississippi will encounter difficulties totally unknown to their ancestors."* We know all too well how this prediction has been fulfilled. With only dogs and buffalo the tribes were feeble and little to be feared; but with horses they became a new people—the Arabs of America, and the most formidable foe that European civilization has met with in her western march.

The Spanish horses were carried to England to improve her breed of war-horses, and were an important element in the rise of British power. And they went to Holland and France; and wherever they went they helped increase national power and national wealth.

But remember, all this is about a horse *to ride*,—a horse that would walk when in no hurry, or trot, amble, rack, or canter on the march to relieve his own or his rider's tired muscles, or on the run sweep down on the place of the enemy like a whirlwind, and then retreat as swiftly, should that be necessary.

Only a running-horse is fit for such work. Try to imagine an Indian raid or an Araby foray on trotting-horses; the very idea strikes one as ludicrous.

Even in Europe the want was essentially the same. With the use of heavy armor in the Middle Ages, a heavier animal was needed; yet he was a *charger*,—a prancing, galloping steed. Imagine a crusader of old, clad in steel, rattling to the charge on a trotter: the suggestion provokes merriment.

Even in later times, when artillery and wagon-trains became

* Volney's View, p. 24.

a part of armies, the want was essentially the same: the heavy horse of the dragoon was fit for the gun-carriage or the baggage-wagon.

It was the war-horse that stood as the representative of his species, from the days when Job's horse snuffed the battle from afar, down through the days of Greek, Persian, and Roman history, down through the Middle Ages, down past the wars of Napoleon, and until the locomotive began to draw armies to the battle-field. The horse for war, the *running* horse, has remained in the lead in all those countries where the road to greatness has been by war. It needed a country wooing the arts of peace, and seeking greatness by industry rather than by conquest, to produce the *trotter*.

In times of peace heretofore he has figured in the ceremonies, and as an index of rank, or with the rich as an implement of sport or an element of luxury.

In agriculture, and as a common beast of burden, he played but a minor part until within the present century, and his little part there was a sorry one. A papyrus in the British Museum tells us what a miserable lot it was in Egypt a generation before Moses wrote, and it did not change much for the better for nearly thirty-three centuries; but with the improvement in roads, and the use of wagons, he had a growing importance as a beast of draught;—yet this did not need fast trotters until new conditions should arise, which will be noticed further on.

Fashion and sentiments in society have always been an important factor in producing breeds of improved horses, and determining the direction the improvement should take.

From the time when an ordinary Roman citizen was forbidden to use *white* horses (and doubtless much earlier than this), there has been a social factor entering into every problem of horse-raising. What colored horses might be used by persons of this rank and of that, who might *hunt* on horseback and who might do it only on foot, indeed, who might ride at all and who not, have been the subject of numerous laws during all the previous centuries, and exist still in some lands not enlightened by Christianity and not possessing the modern trotter.

In all ages the use or possession of the horse has been, in one way or another, an emblem of social position with pagan,

Mohammedan, Jew, and Christian alike. Even now, and in this free country, a carriage and horses means more than the convenience of getting about, and many a carriage and span in front of our churches on Sundays means much more than the convenience of it in getting there. We are told that an enthusiast went to Mentor soon after the election of Mr. Garfield to the presidency, to urge upon him to walk to church rather than to go in his carriage. The newspapers spoke of this social enthusiast and reformer as a bore; he was more probably a philosopher. No, a carriage and horses means much. I say *horses*, for I know people, good Christian people, in my own city, who can ride to the store or to market behind *one* horse on week days, but on Sundays they would rather go to church on foot, or even stay at home, than go with *one* horse. They have a traditional feeling that their social position requires that they worship with *two* horses. We see an evidence of this former sentiment, regarding the dignity of a span as contrasted with a single animal, in the use of the phrase "one-horse affair" applied to anything contemptibly small.

In many countries political and social rank has been related to the possession of horses, and it is still the case in some countries. Fashions, sentiments, the customs of the wealthy or the aristocratic classes in society (where there is an aristocracy), are the really controlling influences as to what kinds of horses are the desirable and high-priced ones raised in times of peace, and as the relative value of the war-horse has declined, new breeds have to be made, or old traits developed in new directions, to meet the new fashions. Fast trotters could never be developed until we had a class of influential people with whom it was fashionable to drive one horse before a light carriage. That class arose in this country: it does not exist even yet in many countries. Incidental to the riding habits in the Middle Ages, there were many fashionable sports that depended upon horses and skill in horsemanship, some of which still survive. For none of these was the trotter suited. Try to imagine gay cavaliers riding in the tournament, and plucking the ring on trotters. Such a thing would be indescribably comic.

In those days, when horsemanship meant so much and was so much interwoven with social usages and sentiments, when the

equery of the king ranked with the prime minister, when princes and nobles vied with each other in the extent and magnificence of their riding-schools, when the riding-school and *menage* was the place of most fashionable resort, there arose an immense horse literature. Some of you know what a fancy I have for old horse literature, and have seen the large collection of old and curious books I have pertaining to horses, written long ago, the oldest printed more than 350 years ago;—well, I have not read them all, I will admit, but I have read very much of this literature, and scarcely anywhere do I find a good word for a horse that trots. Some writers, like the old Duke of Newcastle, prefer a natural trotter to a pacer, but merely because "A Trot is the foundation of a Gallop," while "An Amble being a Shuffling Action, I would have it Banish't the Mennage (A New Method, etc., p. 153, London, 1667);" but nearly all the old writers dismissed the trot with a few words, but devoted much to the amble. In fact, the trot is usually spoken of with positive contempt. In an old French ballad, "*Le lai du Trot*," it is said that those ladies who are kind to their husbands in this world, in the next may ride on beautiful ambling palfreys, but those women who are wicked in this world, in the next will have to ride trotting nags. This but illustrates the esteem in which the trotter was held.

I will not here discuss the nature of the various gaits of the horse further than to say, that in the Middle Ages, and doubtless much earlier, in addition to those assumed by horses naturally, there were many artificial gaits taught. There is an enormous literature relating to this. But the fashion has all passed away. As ambling was then so much more valuable than trotting, it was bred to, and there is abundant evidence that natural pacers were common, but when not natural the gait was taught.

As the canter, gallop, run, and amble were the gaits for the saddle, so the trot is the gait for the carriage, and consequently the history of the trotter is also related to that of carriages.

Chariots and wheeled vehicles of some kind have been used to some extent from the days of the Pharaohs; but in the form and shape in which we know them they are rather modern. Coaches came into use in England in the time of Queen Elizabeth (there had been whirlicotes and various vehicles in slight

use, from time to time, earlier than that), but, until long after, most travelling was on horseback. The roads, compared with those of to-day, were bad, and coaches were heavy. When King George II died in 1760, the Lord Chamberlain, the Duke of Devonshire, arrived in town in three days, having travelled at the "prodigious rate of fifty miles a day," the historian tells us. What need for a fast roadster then, or for any time previous from the dawn of history? No, the fast trotter would have found no place then: if he had existed, he would probably have been neglected, and become extinct.

Four-wheeled vehicles are now so numerous and universally used that we are apt to forget how very modern their common use is. The first stage route between New York and Boston was not established until considerably more than a century after the settlement of both colonies. Lady Murray introduced the first private coach into New York about 1745, but they were scarce until some time after the Revolutionary war, and were unpopular as signs of aristocracy, and carriages were taxed as luxuries in the early days of the republic.

The roads were unfitted to fast travelling until long after the Revolution. The Declaration of Independence of July 4th, 1776, was received at Washington's head-quarters in New York city, and at the Provincial Assembly, at White Plains, on July 9th, five days on the way, and that not considered as long for the times as five hours would be now. It took about as long for the news of the battle of Lexington to reach New York city. What need then, with such roads, for fast trotters? Now that the distance is made in a few hours by steam, we need the trotters to carry us to the station.

The greatest use of trotters is for light wagons, but these in their present form are still more modern. I have made many inquiries about this matter, both in Connecticut and in New York, the regions where the trotter originated. Moreover, my present home, New Haven, is one celebrated the world over for its manufactures of light carriages: so I think my information pertaining to this is sound. Down to the present century one-horse vehicles were usually two-wheeled, and even these not abundant, and were heavy. The present buggy, with steel springs, began to be used between 1820 and 1830, but they were

so scarce and rare until about 1840 as to attract notice when on the street. I well remember the first one I saw, and it was eyed with curiosity.

* * * * * * *

The introduction of light one-horse wagons with steel springs is coincident with the formation of the first organizations for the breeding, training, and speeding of trotters, and such wagons only began to be common just at the time when we had developed the first 2:30 trotters. Fast trotters had to develop in a country where there was a passion and taste for the animal, and something to make a trotting sulky of, and America is the native land of the hickory as it is of the trotter. Without hickory to make our wheels of, could we have trotters with such low records as we now have? The development of trotters and of vehicles have gone on together: we did not need the fast trotter for driving until we had suitable wagons. Without springs, no roughness escaped the traveller. My father had one of these so-called light wagons, with the box down upon the axle, and he had a mare he thought would trot a mile in three minutes. One of the most vivid recollections of my childhood is of that mare before that wagon, and a bit of corduroy road near the old home. But that was the common experience of all, and as it had been from the beginning of carriages. How often I have looked and wondered at the pictures of the ancients in their chariots. A Roman emperor in his triumphal chariot, in all his pride and glory, must have been riding about as comfortably as he would have been in a modern ox-cart. There was some mitigation by cushions; but no one travelled for pleasure with light carriages until steel springs came, and until then there was no need and no place for fast trotters.

And yet trotting attracted attention much earlier than that in this part of the country. I am by no means clear as to why this fancy, for fancy it was, should have sprung up here; but, from all I can learn, it had its origin in New England and in eastern New York.

The American horse, as he was the last part of the last century, sprung from a number of sources. Over the whole of South America, the West Indies, and Mexico it was of Spanish origin. Sir Walter Raleigh, already, in his time, said that the horses of

the West Indies were as fine as any he had ever seen. But in the United States the origin was more composite. Horses had been brought mostly from England, France, and Holland, a few from Sweden and from Spain, and Frank Forester has argued from the build of some that there must have been importations from Ireland. The French stock went mostly to Canada, and from that province their blood filtered down into New England and New York.

Blood from these various sources mingled, and gave rise to local breeds or sorts, differing somewhat in different localities, partly because of differences of the imported blood, partly from the natural conditions of the region, and partly from the breeding. One type formed in Canada, another in Vermont, and in Rhode Island we had the famous Narragansett pacers, one of the few pacing *breeds* of which we have knowledge. We have had many pacing horses, but they have not been spoken of as breeds. This is reported to have sprung from horses imported by Governor Robinson from Andalusia, in Spain, crossed on the native stock of the state. There is frequent mention of it during the last century, but the breed (if indeed it can be called a breed) has long since run out by crossing: no one seems to have cared enough for it to keep it up and improve it. It died out as the taste for trotters grew. The breed ran out much as the Morgan breed did, by out-crossing.

It is only in recent times that the efforts to improve live-stock have been chiefly by keeping the blood pure. Down to very lately the common method of improving the stock of a country has been by crossing it with something else.

The almost universal testimony of writers who visited this country before the present century is, that the horses degenerated in size. This is not the place to discuss all the reasons for this, but the fact is undoubted; but if they lost in size, the testimony is equally strong that they gained in hardiness and endurance.

After the War of Independence, under a better condition of things, pastures became better, roads better, there was more wealth, more travel, and with all this a demand for better horses. The English Thoroughbred, the best race-horse in the world, was then more abundantly brought in, partly for racing pur-

poses and partly for the general improvement of horse stock; and this blood, crossed on the hardy native stock spoken of, has been the source of nearly all the best roadsters of the country, and is emphatically the source, so far as blood is concerned, of nearly all the improvement of the last ninety years.

For some cause the trotting gait became popular in Connecticut in the last century (a similar taste sprung up in a part of Russia about the same time, and the Orloff trotter is the result). A few years ago I looked through the files of the *Connecticut Journal* (published in New Haven), from the war of the Revolution down to 1817, column by column, advertisements and all, and noted every item pertaining to live stock. I tabulated certain facts pertaining to horses several different years between 1787 and 1802, height, colors, foot-marking, gaits, etc., of all the stallions, horses for sale, strayed, stolen, etc. Some of the data may interest you.

Thus, in 1787–'89, of seventy-eight horses advertised (ten of them stallions), the heights of forty were given;—only two of them were above fifteen hands, and the average height of all was fourteen hands: bay was the most common color, black next. The next two years, of twenty-nine horses, ten were black; the average height of the twelve whose height was given was thirteen hands three inches, and so on. In describing horses, the gait was often given. In the four years, 1788 to 1791 inclusive, the gaits of seventy-five are stated. Of these we have "natural trotter," twenty-seven; "trots all," "natural to a trot," "trots well," "fast trotter," "trots and canters," and "square trotter," fifteen; total trotters, forty-two of the seventy-five. There are fourteen "natural pacers," six "trot and pace" or "trot, pace, and canter," the others have varied or mixed gaits. In 1796 and 1797, of thirty-five horses whose gaits were stated, twenty-six were described as trotters, two as pacers, and seven both trot and pace. In 1802–'4, of sixty-nine horses thus described, fifty-four were natural trotters, five were natural pacers, and ten both trot and pace. A writer in *Wallace's Monthly*, July, 1879, p. 425, has noted that in the *Connecticut Courant*, published at Hartford, various Dutch horses, 1765, 1798, etc., are described as trotters.

A stallion called "Game Leg" was advertised in the *Con-*

necticut Journal of April 30, 1788, by William Fowler, of North Guilford, and described as seven years old, bright chestnut, and "supposed to be the swiftest trotter in Guilford." This is the earliest "trotting stallion" that I know of. There are many indications that as early as the close of the Revolutionary war there was considerable attention paid to trotting-horses in Connecticut and New York, and perhaps also the other states north of Philadelphia.

Horses were extensively bought for shipment to the West Indies, New Haven being an important port of shipment. The animals were brought here from the interior of the state, and from the adjoining states. I now live in a house built by one of the horse-shippers of a previous generation, and the large barns and stables where the animals were stored before sailing disappeared before the march of city improvement but a very few years ago. Numerous advertisements show what kinds of horses were wanted. "A number of pacing horses wanted immediately." "Wanted, a few natural PACERS." "Cash will be paid for some pacing horses." "Wanted, a number of sprightly shipping horses, in good order, proper for the French market" (French market meaning the French West Indies). "Wanted, thirty likely young pacing horses." "Wanted, forty-five good shipping horses for the W. I.; pacers preferred," etc., etc. Such was the common run of advertisements during the last years of the last century: sometimes trotters were asked for, this want becoming more frequent after the beginning of the present century. Thus, in 1802, are advertisements: "Wanted, a number of pacing and trotting horses, for shipping." "Wanted, likely young horses: smooth pacers or single-footed trotters will suit best." "Wanted immediately! a number of likely young horses, for which cash will be paid. They must be from thirteen to fourteen hands high, stout, thickset, and *all square trotters;* bay, sorrel, chestnut, and grey colors, without any white feet." "Wanted, a number of trotting and pacing horses for the French market," etc., etc. While *pacers* are more often spoken of as wanted, yet from time to time there are wanted "trotters suitable for the French market." I have a strong suspicion that a sort of fancy for trotters had also sprung up in the French West Indies, and that our thrifty

Connecticut Yankees were quick to see the profit in breeding them.

When trotting on the course began I do not know, but the first definite notice of such that I am acquainted with is the following, which I copy from the *Connecticut Journal*, New Haven, June 19, 1806:

"*Fast Trotting.*—Yesterday Afternoon the Haerlem Race Course of *one mile's distance*, was trotted around in *two minutes* and *fifty-nine seconds*, by a Horse called *Yankey*, from New-Haven, a rate of Speed, it is believed, never before excelled in this Country.—*N. Y. Spect.*"

This is twelve years earlier than the date given by Frank Forester as the beginning of trotting for money; and this brings me to a phase of the subject I have not before even alluded to, but which is by far the most interesting for scientific study.

It is as an instrument of gambling and of sport that the trotter has most scientific interest, because here we have the fullest details, the most abundant records, and the most exact data. The interests involved are so large, so many of the best trotters are devoted to it, so many persons are interested, so many thousands, even millions, are staked, won, or spent upon it every year, the records of success and failure are kept with such careful labor and accuracy, and the pedigrees of the winners studied and investigated with such care, that it constitutes one of the most interesting studies in biology. To trot fast has not heretofore been natural to horses;—we are making it so by training and heredity, demonstrating the heredity of education and acquired habits and characters; and the records of the turf are the chief data we have for an exact and scientific study of the history and progress of the work.

The English Thoroughbred is a running horse: for this he has been bred and developed. He is very rarely indeed a fast trotter, and usually does not trot willingly. But he has the general form for a swift horse, and those mental qualities and instincts which specially fit him for the course; and the breed of trotters that is now forming is made out of a cross between this noted breed and the common stock of the country, said "common stock" being a mongrel mixture from various original sources, as has been already pointed out.

A new breed of animals is never made by crossing two, and

only two, distinct breeds, and preserving the better qualities of both. I am not aware that there is any such case on record among all of the countless breeds of our domestic animals. But new breeds are often made of *several* original breeds by a selection from the mongrel progeny. Numerous examples of this can be cited. Also, by the use of one specially improved breed on the mongrel stock of several mingled breeds. We have several examples of this also (particularly among sheep), and the trotter belongs to this category, so far as he constitutes a breed.

Some thoroughbreds have shown a special aptitude to beget trotters when crossed on this common stock. Prominent among these stands *Messenger*, who was imported about 1788, and was the sire of a numerous progeny; and he is believed to have exerted a greater influence on the trotters of to-day than any other one animal;—but this has been the subject of so much talk and writing I will not follow it any further than to say that I have no doubt of the truth of the general fact.

There was little horse-racing in early times in the Northern colonies. The colonists who settled along the coast from Delaware Bay to the Bay of Fundy were largely religious enthusiasts, who had little sympathy with this sport. In the Old World they had mostly belonged to the middle class of society, the producing class, the thrifty class. In the minds of English, Puritan, French, Huguenot, Dutch, Walloon, and Scotch Presbyterian alike, horse-racing was associated with aristocratic privileges and unthrifty ways, if not with the worse objection of immorality. It was among this stock that the love of trotting began. The trotter could never have originated south of Mason and Dixon's line, where horse-racing was more popular, nor indeed in any country where horse-racing was a fashionable sport with the better class of society. The taste had to arise where running was under a cloud.

After the Revolutionary war, during the last years of the last century and the first years of this, a considerable number of English thoroughbreds were imported, both for running and for improving the horse stock of the country by crossing. Horse-racing rapidly grew in favor, particularly in the Middle states, as we had an increasing number of men who could afford to indulge in the luxury.

But old prejudices remained, a strong reaction took place, and the sentiment against horse-racing became so powerful, that most, if not all, of the Northern states passed stringent laws against it, with heavy penalties of fines or imprisonment. As an illustration of the sweeping prohibition attempted, I will quote from the laws passed in Pennsylvania about 1820, which not only forbade horse-racing itself, but also forbade even to "print, or cause to be printed, set up, or cause to be set up, any advertisement mentioning the time and place for the running, pacing, or trotting of any horses, mares, or geldings, or shall knowingly suffer any advertisement, as aforesaid, to be set up in or upon his or her or their dwelling-house," etc., etc. A law similar in character existed on the statute books of Connecticut until three years ago, when it was repealed. The effect of these laws was to discourage the importation of thoroughbreds; and Frank Forester states, as a consequence, that there were fewer in the country in 1850 than in 1820.

There was some racing in most of the states (less in Connecticut, and consequently her horse interests declined) in spite of hostile laws, but the sport was under a cloud, and trotting apparently came in to supply its place. I am inclined to believe that the desire to see a horse go at its best speed is an instinct with our race, and means will be found to indulge it, even under the most hostile laws.

Frank Forester says that trotting *for money* began in 1818, and grew out of a jockey-club dinner at which Major Jones of Long Island bet Colonel Bond of Maryland $1,000 that "no horse could be produced that could trot a mile in three minutes." There was much side betting, and the odds against it were immense. But *Boston Blue* won handsomely, and Major Jones lost his thousand dollars. This trot made much talk at the time, and an account says that this wonderful horse, which could trot a mile in three minutes, was taken to England to exhibit there. This was a *trot against time*, but time had been taken earlier. I have alluded to the trot of Yankey in 1806; and the *London Sporting Magazine* of October, 1810, is cited as having a letter that tells of a trot in August of that year, in which "a chestnut horse from Boston" trotted to a sulky one mile in 2.48¼, for $600. Doubtless there was occasional trot-

ting, just as there were other queer races, just as we hear of a hog-race and a goose-race; but trotting as a sport may be said to have fairly begun between 1815 and 1830, and they were frequent enough before 1820 to be specially mentioned in prohibitory statutes. Under the repression of hostile laws against races, other means were taken to gratify the instinctive pleasure of seeing horses get over the ground swiftly. A race, as then understood, was a contest between two or more horses, to see which could run the fastest, as it is still in most countries. Men did not dream of a *race* being run by *one* of anything, be it in a horse-race, boat-race, or foot-race. Moreover, in those times horse-racing meant horse-running. So when horse-racing was a crime punishable by fine and imprisonment, the good, law-abiding citizen who owned a good trotter, and who instinctively yearned for the pleasure of seeing a spirited horse in action, would not *run* him, nor *race* him; he merely "trained" him, and had an occasional "*trial of speed*," in which he could hold his watch and see how long it took his horse to trot a given distance, and the "timing" of trots became common long before the system of records was established.

New York had passed "An act to prevent horse-racing," March 19, 1802, which was amended March 30, 1821, by which it was enacted "that from and after the passage of this act, the training, pacing, trotting, and running of horses upon regulated courses and upon private property in the county of Queens, is hereby declared to be exempted and free for five years from the provisions and penalties of an act entitled an act to prevent horse-racing," etc. (Revised Statutes, N. Y., ed. 1836, III, p. 282.) The races were allowed only in the months of May and October; and Section III provided that the sheriff of the county should be on hand at these "trials of speed" (as the statute calls them) to see that all was conducted in a way conducive to good morality. When this amendment expired by limitation, it was reënacted April 3, 1826, extending the privilege for ten years, and until March 30, 1837 (*ib.*, p. 283); and in 1834 another amendment allowed "the trials of speed authorized by law in the county of Queens" to take place between the first day of April and the fifteenth day of June, and between the first day of September and the fifteenth day of November of

each year. It is only just to say that "trials of speed" were finally declared by statute to be horse-racing, and liable to the penalties thereof unless exempted by special act.

I have been thus particular in giving these dates, because it marks an epoch in the history of trotting. It is the beginning of organizations for the special improvement of trotting horses, although the provisions nominally extended to pacing and running also.

The New York Trotting Club was organized in 1825, with a view of *improving the speed of road horses*, as the old racing-clubs and jockey-clubs had been to improve *riding*-horses. Their course was near Jamaica, L. I., about a mile from the old Union course, and was probably the first *trotting*-course in the world. The Hunting Park Association was formed at Philadelphia in February, 1828, and the next year measures were begun for a trotting club at Baltimore; and then organizations spread rapidly. The *American Turf Register* began in 1829, and recorded the trots, and by this time, or certainly by 1830, trotting may be said to have become an established sport, rapidly increasing in popularity. There was for a time a feeling with many that it was a sort of rustic sport, fit for the masses, as running had been for the wealthier classes. But that very thing, that it was adopted by the masses, was a great gain in the end.

By this time the names of a score or two of horses became well known to the public as trotters, many of the names as plebeian as the sport was held to be. We hear of Betsey Baker, Bowery Boy, Bull Calf, Burster, Ephraim Smooth, Jerry, Jersey Kate, Paul Pry, Rattler, Rob Roy, Sally Miller, Screwdriver, Top Gallant, Whalebone, and a score of others, now this one to the front and then that. Top Gallant (foaled about 1806) was perhaps the most popular horse of his day. He does not appear to have won much nor often, yet, like some politicians, he preserved his popularity for all that, and his time, 2.40 (although beaten the same year by the Treadwell mare), was the slang phrase for speed for twenty years later. He lived to a good old age (as so many trotters have done), and it was claimed that when nineteen years old he could still trot in 2.45 with a man weighing one hundred and fifty pounds on his back (*American*

Turf Register, November, 1829, p. 122). In 1832 Burster trotted in 2.32, and then became affectionately known as "Old Buster." Next came Edwin Forrest, who lowered the time to 2.31½ on the Centreville course, L. I., May 9, 1834. This track was too long;—if allowance be made for this, the time for an actual mile was nearly a second better; but as it was it took nine years more to beat it, when Lady Suffolk lowered the record to below 2.30.

I have used, for convenience, only the mile records. Were we to consider all the performances, the best horses and the best records would not coincide with my list. In those early days most of the trots were for distances greater than one mile, usually for two, three, or four miles, often longer; and, moreover, before 1840, most of the trotting was under saddle, while now it is mostly in harness. The time came to be more and more carefully kept, and thus "records" became an established feature.

As this is a distinctive American custom, and began with the trotters, I will notice it more fully. Records are not kept in England, and because they are not, we cannot study the development of the horse-race as we can that of the trotter. I have already shown how speed was noted by timing;—later, specific rules were established, and now a word of explanation to the innocent as to what a "*record*" at present means.

The laws of sporting are very exact, the code is planned with more care, deliberation, and wisdom than most of our national and state laws are, and in the racing code of this country any contest for a purse, premium, prize, stake, or wager, on any course, and in the presence of a judge or judges, constitutes a public race. The time made by the winner is a "record." There is no record unless the horse wins, so a list of records does not tell how fast some of the horses may have trotted; they may have done better than their record, and, not winning, get no credit for it. Or a horse may trot never so fast, and if there is no money or prize won that is no record. To illustrate: Dexter made his record of 2.17¼ at Buffalo, August 14, 1867, by winning. But in June of the same year, with Ethan Allen as a running mate, he was timed a mile in 2.16. This is well authenticated, but is no "record." Again: Edwin Forrest, in

August, 1878, at Hartford (the day of a great feat by Rarus, and I dare say several of my hearers were present), trotted a mile in 2.14¼. There were many thousands of spectators present, judges in position, the time as carefully noted as in any race in the world, another horse trotted with him to encourage him, yet his time made was no "record," because there was no "purse, premium, prize, stake, or wager" involved. It was a mere exhibition. Consequently, the story of the trotting horse is much better in fact than can be shown by any table of records. But as these are the only exact and well authenticated data we have, I use them, and because of the uncertainty of many alleged times which are not records, I must ignore all such in this discussion.

Records only dropped below 2.30 in 1843, in which year Lady Suffolk (and Beppo?) trotted in 2.28, but it had often been claimed to have been made before. It was claimed that Bull Calf did it when six years old (*American Turf Register*, January, 1830, p. 257), and several horses had trotted one mile of a longer race, in less than 2.30. Dutchman, in a match against time on the Beacon course, August 1, 1839, made the second mile of a three mile race in 2.28. His record of 7.32½ for the three miles under saddle, made at that race, still remains the best of its kind, 3-mile heats under saddle having long since become very rare. But times, even when not records, were valued for driving purposes quite early. A note by the editor of the *American Turf Register*, June, 1830, p. 483, says that in New York or Philadelphia a horse is so commonly estimated by his performance at trotting, that "if you ask an ignorant stable boy 'What sort of a horse is that?' he will answer, 'Well, I guess he's a three or a three and a half,' meaning so many minutes and seconds for a mile." The *American Turf Register* was established in 1829, and with that, records in our present form may be said to have begun, although the "*Trotting record: containing a list of all published performances in which any heat was trotted in 2.40 or less from the earliest dates*," in Wallace's *American Trotting Register*, I, p. 325 to 468, I think, cites no records earlier than 1830 as worthy a place there.

Just as records became an established fact, light steel-spring wagons began to be made, and between 1835 and 1845, driving

to light carriages became exceedingly fashionable, particularly about New York. Several European travellers of that time speak of it as a curious fashion, and, being unknown in England, they did not speak of it usually with admiration. The old prejudices against trotting lingered, and a writer in *The London* (New) *Sporting Magazine* for July, 1839, speaking of sporting in the United States, where "*trotting* is the order of the day," says,—"Our cousins on the other side of the water are mad in the encouragement of that nasty, awkward, ugly, Chelsea-water-works style of action which characterizes the fast trotter." He allows, however, that "there is method in the madness," and that the best trotters bring big prices.

Although I have brought the history down to the time when there was only one (or two?) record in the world of 2.30, the story is nearly told. A famous capitalist is reported to have said that it was easier to make a thousand dollars out of one than one out of nothing. It appears to have been just so with trotters. It took from 2200 B. C. to after A. D. 1800 to produce one three-minute trotter;—many thousands have been produced since.

I invite your attention now, specially to the two tables I have hanging on the wall. The first is a *Table of Best Records* (see below), showing progress in the rate of speed, from Yankey in 1806, to Maud S. in 1881, the earlier ones on the list, it must be understood, not being authenticated records in the sense that that term is now used.

TABLE OF BEST RECORDS.

1806.	Yankey,	2.59
1810.	A horse from Boston,	2.58½
1818.	Boston Blue,	3.00
1824.	Top-Gallant,	2.40
1824.	The Treadwell Mare,	2.34
1830.	Burster,	2.32
1834.	Edwin Forrest,	2.31½
1843.	Lady Suffolk,	2.28
1844.	Lady Suffolk,	2.26½
1852.	Tacony,	2.26
1853.	Tacony,	2.25½

1856.	Flora Temple,	2.24½
1859.	Flora Temple,	2.19¾
1865.	Dexter,	2.18¼
1866.	Dexter,	2.18
1867.	Dexter,	2.17¼
1871.	Goldsmith Maid,	2.17
1872.	Goldsmith Maid,	2.16¾
1874.	Goldsmith Maid,	2.14
1878.	Rarus,	2.13¼
1879.	St. Julien,	2.12¾
1880.	Maud S.,	2.10¾
1881.	Maud S.,	2.10¼

The following "*Table, showing Number of Horses, with their Records*," (p. 316) shows at a glance the number of fast trotters which have trotted with the several records since 1843, when we first began to have a 2.30 class. In explanation of this table, I will say that from 1873 on, I have used the figures given by others, only the arrangement and collation is mine. For the figures from 1843 to 1871 inclusive, I am responsible. The first list of 2.30 horses known to me appeared in *The Turf, Field, and Farm*, Vol. XVI, p. 117, February 21, 1873. A writer over the signature of "Ajax" published a list of 323 names, with their best records, arranged in the order of the records. This list must have cost him much labor, but being the first of its kind, and from the intrinsic difficulties of the case, it was very imperfect, so much so that I do not here use the figures. But it was a beginning, which "Ajax" and others later improved, and from that time lists of 2.30 horses in some shape have appeared each year, the lists of 2.25 horses being quite numerous and prepared with much care. For the figures up to 1871, I have gone over the printed records to that date, and made a card catalogue of the 2.30 horses year by year, with the records as published. To make the showing as good as possible I have included in my figures records under saddle, and records with running mate, except two which affect the best records of their respective dates. Moreover, I have not cerefully weeded out all where the track was too short or for a few other technicalities. Hence my figures are larger in several cases than the

strict records, according to the rules of to-day, would allow. But as the table has been prepared as a study in the evolution of a breed, and the figures are for relative use and comparison, their value for this purpose is not impaired by this kind of inaccuracy. I can only say that they are approximately correct, that they have cost me in the aggregate some months of labor, and that absolute accuracy is now out of the question. The printed reports abound in so many errors, typographical and otherwise; there are so many irreconcilable statements, so many disputed points where experts differ,—that no table will probably ever be made that will be accepted by all as entirely accurate. A better one can probably be made when *Chester's* forthcoming "*Complete Trotting and Pacing Record*" shall have been published, if any one will carefully collate all the "35,000 events," and I hope, in the interest of science, some one will have the time and inclination to do it. The following table is the only one of its kind I have yet seen, and inaccurate and imperfect as it may be, and must be from the very nature of the case, nevertheless it is the most interesting series of figures ever yet brought together, illustrating the evolution of a breed.

TABLE—SHOWING NUMBER OF HORSES, WITH THEIR RECORDS.

	2.30 or better.	2.27 or better.	2.25 or better.	2.23 or better.	2.21 or better.	2.19 or better.	2.17 or better.	2.15 or better.	2.13 or better.	2.11 or better.
1843	1									
1844	2	1								
1849	7	2								
1852	10	3								
1853	14	5								
1854	16	6								
1855	19	6								
1856	24	7	1							
1857	26	7	2							
1858	30	7	2							
1859	32	9	2	1	1					
1860	40	11	4	2	1					
1861	48	14	4	2	1					

TABLE—SHOWING NUMBER OF HORSES, &C.—*continued.*

1862	54	17	7	4	1					
1863	59	19	9	4	1					
1864	66	22	12	4	1					
1865	84	29	15	5	2	1				
1866	101	32	17	6	3	1				
1867	124	42	21	9	5	2				
1868	146	52	28	13	6	2				
1869	171	63	34	15	10	4				
1870	194	72	35	16	11	5				
1871	233	99	40	17	12	6	1			
1872	.....	.....	.....	.....	.....	.....	.....			
1873	376	.....	74	28	15	5	2			
1874	506	.....	98	40	16	11	5	1		
1875	.....	.....	134	61	30	13	5	2		
1876	794	.....	165	81	39	16	6	2		
1877	836	.....	214	105	51	19	8	2		
1878	1,025	.....	270	129	68	24	9	4		
1879	1,142	.....	325	164	88	33	11	5	1	
1880	.....	.....	366	192	106	41	14	6	2	1
1881	1,274	.....	419	227	126	49	15	7	2	1
1882	1,421	.....	495	275	156	60	18	8	2	1

Let us now return to the subject of the best records, with the table before us: Lady Suffolk began the 2.30 list in 1843 (over 1,400 have since dropped into that class), and the next year lowered the record to 226½. It took eight years to better that, but in the thirty years that have elapsed since that record was lowered some 600 or 700 have done better, and many thousand heats have been trotted in less time. It has often been made with teams on the highway.

Then Tacony came and twice lowered the record, but he never created the enthusiasm that his successor Flora Temple did. She lowered the record to 2.24½ in 1856, and again to 2.19¾ in 1859. We began now to have a 2.20 class, and what an enthusiasm it created! Flora Temple became a household word: ladies wore Flora Temple bonnets, boys smoked Flora Temple

cigars, politicians drank Flora Temple whiskey. It is not probable that any one trotter will ever again create such an enthusiasm. She died only five years ago in her thirty-third year. I have seen several statements as to her winnings, which were large. Then came Dexter, lowering the record twice before retiring from the turf; then Goldsmith Maid, whose speed and fame are said to have brought her owners near a quarter of a million of dollars; then Rarus, St. Julien, and Maud S.

We have followed this evolution through. We have seen the sentiment starting, apparently in New England, which produced the earliest trotters, then spreading to the Middle States where it had its greatest growth, and then it spread through those parts of the world where there are good roads and light carriages. It has been claimed that trotting was started first in Italy. Projects for trotting-courses were advocated in France as early as 1834, and in Normandy in 1832, and there has been a slow development in various countries of Europe. But the real development has been here, although now there are trotting courses in most civilized countries of the world. I received last year trotting records in Norwegian.

We have traced its growth and seen what a combination of causes has been at work in society aiding in the development;—sentiments against horse-running, and a taste for trotting taking its place; a few French West Indians wishing trotters rather than pacers (possibly because better broken to the gallop); improvement in wagons, and the invention of steel springs; a fashion arising of driving horses single; hickory to make light wagons of; the needs in our modern city business requiring quick roadsters; changes in the methods of war; introduction and widespread use of railroads for quick travel and heavy transportation. The spirit of the age, etc., etc., have all been factors in this most interesting problem,—factors, the separate value of which would be very differently estimated by different persons viewing the subject from different standpoints.

Professor Marsh has shown us how the horse has developed in previous geologic ages from a small, weak, and awkward animal; how that, growing in size, and strength, and fleetness, and beauty, the developed horse was on the planet ready for man when he came. I have tried to show how man has taken

this and modelled it into something even better and higher, the trotter being the latest and best.

The horse of old was the horse of the warrior, and was bred for the battle-field or for ceremony, and his use and possession was for the wealthy. The trotter originated among the masses as soon as the masses were free. He developed for use as well as luxury, the horse for both business and pleasure, the horse alike for the bustle of the busy streets and for the quiet family carriage. The horse of old was the horse of war and of waste; the trotter is the horse of peace and of thrift, the highest equine product of the modern highly developed Christian civilization.

"SWELL-HEAD" IN CATTLE.*

CHICAGO, Nov. 6, 1883.

OSCAR C. DE WOLF, M. D.,
Commissioner of Health:

SIR:—In compliance with your request, I have investigated the nature of the disease commonly termed "swell-head," as exhibited by cattle received at the Union stock-yards, and have the honor to submit the following report:

I have had an opportunity to examine personally only five head of these cattle. I am informed by your inspector, Mr. Lamb, that a large number of such animals have been received prior to the commencement of my investigation, but that the number has diminished rapidly in consequence of the active measures which were instituted, under your instruction, for keeping the flesh of these animals out of the Chicago market. With your permission I shall examine the animals which may be hereafter received at the yards; though since the nature of the disease is perfectly apparent from the cases already investigated, such further examination will possess a scientific rather than a sanitary value, and need not delay this report.

The five animals examined belonged to four different lots which had been shipped from the West: as to the exact localities from which they came, I did not obtain definite information. All but one of these animals were in poor condition. Their hides were rough and their bodies much emaciated. Each presented a swelling on the face, the smallest tumor being about as large as an orange. This was the least emaciated animal of the lot, the largest tumor being about the size of an average muskmelon. In three cases the tumor was connected with the upper

* Reprint from the advance sheets of the transactions of the American Public Health Association. By permission of the Secretary, Dr. I. A. Watson, Concord.

jaw; in one, with the lower jaw; the fifth was located just below the animal's eye. In every case except the last the tumor was hard and resisting, feeling and cutting like gristle: at different points softer, semi-fluctuating spots were felt. The surface of the growth was raw and ulcerated; a little thick pus covered portions of the ulcer. Upon cutting into the mass, it was seen that the greater part of the tumor consisted of hard, white material, which looked like cartilage gristle, but was discovered with the aid of the microscope to be an unusually firm connective tissue. This mass was firmly attached to the bone, so that it was not always easy to distinguish the line of separation between the two. The bone itself was enlarged and very soft, so that it could be readily cut with a strong knife; it was, moreover, honeycombed with channels and cavities containing thick pus. The gristly tissue outside of the bone exhibited cavities having similar contents. This pus, the walls of the cavities, and the surface of the ulcers, contained numerous yellow bodies, usually about as large as pin-heads. My first glance at these bodies raised a suspicion which the microscope soon showed to be well founded: these little yellow masses are groups of a microscopic plant called *actinomyces:* the disease caused by their growth in the animal's flesh has been accordingly named *actinomycosis*. Since this disease has never as yet been recognized in America, and since it attacks men as well as cattle, I shall take the liberty of including in this report a brief sketch of our present knowledge of the subject.

Our knowledge of the true nature of this disease, like most other recent advances in pathology, we owe to the Germans. It had long been known in this country, as well as in Europe, that cattle were often afflicted with tumors upon the face, which gradually increased in size, and finally caused the death of the animal. These tumors were supposed to be cancer, sarcoma, tuberculosis, etc., and are still so designated by veterinary surgeons in America. In 1877, Bollinger, Royal Professor of Veterinary Medicine in Munich, Bavaria, discovered that these tumors contained large numbers of a microscopic plant, which grew not only on the surface, but also in the interior of the mass, and permeated the bones. This discovery of Bollinger was soon fully confirmed by extensive observations of cattle by other sur-

geons. It was found that this particular plant was present in these tumors. That the plant actually causes the disease has been shown by Ponfick, Johne, and others. These observers separated the plants from the tumor, and introduced these isolated organisms into healthy animals. When thus inserted into the abdominal cavity, or injected into the blood of healthy cows and calves, the plants flourished luxuriantly in their new abode, and caused the appearance of similar tumors in these previously healthy animals.

The word "actinomyces" is compounded of two Greek words signifying *radiating fungus*. The plant is so named because its parts radiate from a central point, like the spokes of a wheel. It is a fungus, belonging to the same general family as the moulds which grow upon jelly, moist bread, etc. Other plants of this family have long been known to cause several diseases of men and animals: ringworm in children, and the mange in dogs, are familiar examples of diseases caused by fungi. Many of these require air for their growth, so that they flourish only on the surface of the body; some of them, including the actinomyces, can maintain their existence in the interior of the tissues.

The original habitat of the actinomyces has not as yet been discovered,—a lack which is quite comprehensible when we remember that the plant is of microscopic dimensions, and was discovered only six years ago. It seems to be originally a parasite upon grain, and to gain access to the animal with the food. The reasons for this supposition are,—first, that this parasite has been found as yet only in grain-eating animals—the cow, the hog, and man; second, that it usually grows in the jaws or on the tonsils; third, numerous other fungi are known to be parasitic upon vegetables: the ergot of rye is a familiar example.

As has been remarked, these tumors usually occur around the jaws. It has been supposed that the parasites, taken into the mouth with the food, gain entrance to the jaw-bone through the cavities left by carious teeth. I examined the teeth in my cases,—in one instance, that of an old bullock: several teeth were gone, and two carious stumps were present on the side of the jaw affected by the tumor; yet I could not satisfy myself that the growth had begun at this point. It is possible that the plant grows downward between the tooth and the gum, and thus

invades the jaw-bone. The course of this disease in cattle is various;—some cases have been known to recover spontaneously; in others, energetic treatment has, in the early stages, succeeded in arresting the disease. After the jaw-bone becomes involved, however, the growth usually causes death.

In cattle the parasite usually spreads through the tissues only by continuous growth; but they occasionally gain access to the blood, and are thus carried to distant parts of the body, where they produce similar tumors. In some cases the lungs have been found thickly studded with the plants, presenting a picture resembling tuberculosis.

Within the past four years it has been discovered that this disease attacks not only cattle and hogs, but also the human species: more than thirty cases of actinomycosis in human beings have already been reported by German observers.

In man the disease presents a different aspect from that observed in cattle. In many cases it begins as a swelling of the jaw, and it has been demonstrated that in the human animal, at least, the parasite gains entrance to the body through the cavities of carious teeth. In other cases the tumor appears not upon the face, but upon the hand or arm; in fact, a scratch anywhere upon an exposed surface of the body seems a possible beginning for the disease in those who are compelled to handle cattle or grain.

In man the disease does not remain localized, as is often the case in cattle, but rapidly spreads to the internal organs of the chest and abdomen. In many cases the spinal column also is invaded by the parasites. Hence the symptoms presented by the patient vary extremely, and often simulate those of other diseases. In nearly all cases thus far reported the affection has been supposed to be blood-poisoning, pyæmia, pleurisy, inflammation of the bowels, Potts's disease of the spine, etc., the true nature of the complaint having been recognized only by a post-mortem examination. Hence it is highly probable that the disease frequently attacks human beings resident in infected districts; but it is not recognized, and is called by some other name. Human beings seem to afford a more favorable soil than cattle for the growth of the plant, since in man the disease is invariably fatal. It is, of course, possible that if the nature of the

complaint be recognized, and treatment promptly adopted, the disease might be just as curable in man as in cattle.

The disease is contagious,—that is, it can be communicated to a healthy animal by contact with one already diseased. That it can be communicated to men by contact with diseased cattle has not as yet been demonstrated, but is certainly highly probable. Whether the spores of the plant are wafted about in the air, and whether the disease can be thus disseminated, is not yet determined.

This is, so far as I am aware, the first recognition of actinomycosis in America,—that is, it is the first time in which the true nature of the disease called "swell-head," cancer, sarcoma, etc., has been recognized. The disease would appear to be quite prevalent among the Western cattle, if we may judge from the fact that scores of animals suffering from it have been received at the stock-yards within the last few weeks. It is to be hoped that the importance of the matter will be recognized, and the disease investigated by stock-raisers and veterinary surgeons throughout the country; for the affection is, at least in its early stages, curable, and by proper attention thousands of animals may be saved, and the prevalence of the disease correspondingly limited.

The question which immediately concerns the health department, as well as the city generally, is, whether the flesh of these animals is fit for food. No one who might see the animals which I examined would hesitate in saying that they were in poor condition, and could not furnish prime beef. It is, indeed, self-evident, that an animal whose jaw-bones are honeycombed with pus and encumbered with tumors cannot be so well nourished as a healthy one. In some cases, too, the condition is aggravated by the spread of the parasitic growth to internal organs. It may be safely said that so soon as the disease becomes firmly established in the jaw, the animal deteriorates daily, and cannot furnish unobjectionable meat.

That the beef is dangerous, however,—that there is a probability of communicating the disease to the human consumer,—cannot as yet be positively asserted. All attempts hitherto reported to induce the disease by feeding healthy animals with the infected meat have failed. Moreover, the parasites are destroyed

by thorough cooking, which would, therefore, constitute an efficient protection against these plants, just as it does against danger from that denizen of pork, the *trichina spiralis*. Yet actinomycosis certainly begins, in the human subject, in the cavities of carious teeth, which afford the parasite an opportunity to grow into the bone. Hence infected beef, unless thoroughly cooked, might possibly convey the disease to man. At any rate, until time is allowed for further investigation of the subject, prudence suggests that this meat be avoided.

The living animal afflicted with this disease is, of course, a possible source of danger to human beings, as well as to other cattle. Yet it seems probable that this disease is not communicated through the air by simple proximity, as occurs with small-pox and scarlet fever: actual contact with the diseased part appears necessary for the communication of the disease, that is, for the transfer of the parasite from one animal to another. The fact that actinomycosis has been observed on the tongues of cows, suggests the possibility that they may have acquired the disease by licking the raw surfaces of other animals already suffering from it.

The actinomyces found in these animals seem to exhibit a slight difference, in one respect, from those specimens which I secured and examined in Germany. Two varieties of the plant are already known there: it will be decided by further study whether mine is one of these, or a new variety peculiar to America.

Respectfully yours,

WILLIAM T. BELFIELD, M. D.

MUCK: ITS NATURE AND VALUE.

BY DR. JAMES B. NICHOLS, EDITOR OF THE JOURNAL OF CHEMISTRY.

[Dr. Nichols, who holds a warm place in the hearts of New Hampshire people, and who has on several occasions spoken at our agricultural meetings, has given us permission to publish certain papers which he has read in our state and elsewhere. We are pleased to give them to our people, who will not be likely to see them elsewhere. Some time ago he discussed fertilizers in a meeting at Manchester. Though this particular lecture has not been delivered here, he gave many of its points in his talk in connection with fertilizers. Elsewhere we print his beautiful and instructive paper on "Sunshine on the Farm," which he presented at our Exeter meeting.—SECRETARY.]

MUCK AND PEAT.

The general term *muck* has been given to those deposits of dark vegetable matter stored in low bogs and meadows, and in the bottoms of ponds found upon many farms in the Northern states. The term is perhaps as good as any that may be suggested, although it does not convey a clear idea of any special kinds or varieties, of which there are many. The name *peat* better distinguishes the deposits in most bogs and meadows, but is not applicable to those of frog-ponds and larger basins of water. If the meaning of the word *muck* could be restricted to that class of wet meadow products in which the natural alteration of plant tissues had proceeded far enough to fit them for agricultural uses, it would be a convenience, and remove some confusion which now exists among chemists and farmers. It is not difficult to describe the deposits or their physical peculiarities, so as to make a clear distinction between what might be

called *peat* and *muck;* and in this discussion I will endeavor to point out the distinction.

ORIGIN OF MUCK DEPOSITS.

The origin of the deposits under consideration is not by any means obscure, and may be stated in a few words. Wherever stagnant water has existed in low basins for a large number of years, a certain class of marsh plants, mosses, and grasses has found favoring conditions for rapid and luxuriant growth. These plants have matured and decayed, finding a tomb in the impure waters which fostered their growth. As the decades of years and of centuries succeeded, with the alternations of heat and cold, the basins were filled up, so that surface water disappeared, and matted turf, compacted with low and worthless forms of grasses, came into view. In most cases, deciduous trees and water shrubs grew in association with the grasses and mosses; and the annual fall of leaves and dead twigs contributed not a little to filling up the stagnant ponds and puddles.

Whenever vegetable growths become dead and fall into moist earth with access of air, a process of eremacausis or slow combustion commences, which, proceeding slowly, ultimately ends in entire disorganization of tissue, and the product is called *humus*. The process is different when it falls into the water, as, in the case of large trees and limbs, a dozen centuries will hardly serve to disassociate and change their cellular structure, and some of the finest and most durable timber used in ship and house construction has been exhumed from the vast swamps and bogs found in our own and other countries. The peats and mucks of our own low meadows have to a large extent resulted from the decay of the smaller forms of vegetation, as grasses, leaves, and moss. Of all the various forms which have contributed to our muck-beds, the spongy mosses constitute, undoubtedly, the most important constituent.

THEIR AGE.

How long a time it requires to form a well advanced muck-bed is not certainly known, but under ordinary conditions a hundred centuries may be required, or even five times that number. The

stage of decay in which it is found does not always indicate the lapse of time consumed in the changes, as, under favoring conditions of extreme heat, or access of air during frequent low stages of water, the changes proceed much more rapidly. It is probable that no muck deposits on our farms suited to agricultural uses can have existed, in their lower strata, less than the time which, according to the Mosaic record, man has existed upon the earth.

DIFFERENCES IN MUCK.

When these deposits are carefully examined by the eye, they present very marked and important physical differences. In texture and color no two can hardly be said to be exactly alike. Some kinds consist almost entirely of the withered remains of plants, which have undergone but little alteration except mechanically; in other varieties, the organized structure of the plant remains more or less distinctly visible; in other kinds, there is no obvious indication of plant structure existing. In the latter variety nothing remains but a black, unctuous *mud*, which, when dried, crumbles to a fine dust. I have sometimes found this form of dried muck to be denser than water, having a specific gravity as high as 1.23, but generally it is lower than water, not rising higher than 0.88.

POND MUD, ETC.

It is not necessary, perhaps, to make farther lines of distinction in low meadow deposits. As regards pond sediments, they belong to a distinct class of waste vegetable material, although identical, often, so far as the organic constituents go, with bog deposits.

Three forms of meadow deposits have been pointed out;—those of the *first class* may be called the *immature* forms, where the constituents are coarse and spongy, with fragments of twigs, rushes, and leaves seen in distinct outline. In the *second class*, the organized structure of plants can be recognized, but the decay has proceeded so far as to break them up almost into indistinguishable forms. These products are rather light and spongy, but much denser than those of the first class. The *third class* is the black, dense, perfectly metamorphosed humus,

with a clayey feel, and, when touched, leaves discoloration upon the finger.

The first two varieties I will designate as *peat*, the last *muck*. All these forms when dried are useful for *fuel*, but not for employment upon the farm, unless possibly as absorbents for liquid manures, as a whole. The first two forms had better be cast out of the category of useful farm agents, and attention only be given to *muck* proper.

MUCK PROPER.

Muck, then, considered as the most advanced of all bog deposits, is easily recognized by its peculiar physical conditions, and is the only substance about which farmers need concern themselves; and it now remains to consider its value as a manurial agent. The large amount of water mixed with muck in its natural state is a most serious obstacle to its farm employment. It may be stated to hold a minimum of 60 per cent., and a maximum of 92 per cent., the average being, in New England mucks, not far from 85 per cent. of water. To cut out a water-soaked substance like this from a treacherous, spongy bog, lift it into carts, and haul it long distances, involve great labor and expense. If it is allowed to air-dry on the spot where exhumed, some advantage is gained; but it must be remembered, that under the most favorable weather and conditions for drying, much water remains to be transported. Experiments at my farm upon air-dried mucks, extended over five seasons, showed that water remained in the material to an extent varying from 30 to 47 per cent. It is probable that not many farmers have ever seen a specimen of absolutely dry muck; that is, such specimens as the chemist has in hand in making his analysis in the laboratory. The absolute water-free muck is a light substance usually, which the wind will scatter as it does a handful of feathers. When muck is spread upon a field, much of it blows away in the high winds of summer, when it is very dry from exposure to the hot sun. This is a source of loss not usually taken into account. The light mucks oftener belong to the first and second classes, or what I have designated as peats.

CHEMISTRY OF MUCK-BEDS.

The chemistry of a muck-bed is interesting, and deserves brief remark: the analysis which I have to present will afford information upon this point. It is plain that a substance so under the constant influence and action of water can contain no ingredients *soluble* in that fluid; and hence we fail to find in the ash of muck any of the soluble forms of plant-food. None of the valuable soluble salts of potash, soda, or phosphoric acid are present in the muck-bed, unless in extremely minute quantities. In soils on higher lands, the humus and ash contain all these soluble agents, derived from the decay of vegetation. It must be kept in mind that vegetation decays *in water* under different conditions from that when exposed to air, or in the presence of oxygen, and a different condition of the resultant mass must be expected.

The greater portion of the inorganic material of muck is lime in its insoluble form, silica, iron, alumina, and often magnesia. Of the alkaline earths, lime is present in greatest abundance. From a careful consideration of the results of analysis of a large number of specimens of muck made during the past quarter of a century, under my observation, I have no hesitation in saying *that the ashes of muck are practically worthless to the farmer as a source of plant-food.* I say *practically* worthless, meaning by this that the inorganic constituents of mucks contain so little of valuable, available plant nutriment, that if they held no other forms they would be entirely unworthy of attention, even under the most favorable conditions. This view is sustained by the investigations of eminent chemists in Europe, and Johnson, Storer, and other chemists in this country; in short, it is sustained by the analysis of every competent chemist whose researches have extended in that direction.

NITROGEN IN MUCK.

As regards the other forms of valuable plant-food contained in muck, I have only to consider *nitrogen*. All analyses prove the presence of potential nitrogen in mucks, and in some it is found in considerable quantities. The form in which it exists is in combination with organic acids, the humic, ulmic, crenic,

and apocrenic. It has been alleged that free ammonia has been found in some bogs; but I have failed to detect it in any specimens coming under notice, and no reliable chemist, so far as I can learn, has declared its presence. Nitrogen is the most costly, and, indeed, the most valuable of all forms of nutriment needed by plants, and the question of its value as found in mucks is one of high importance in this discussion.

ANALYSIS OF MUCKS.

In the table of analysis presented below, a clear view is given of the amount found in three typical specimens of muck, one of which is from a bog on my farm at Winnekeni, one from a remarkable deposit in Boxford, Mass., the other from a well-known bog at Plaistow, N. H. The equivalent in ammonia (N. $H.^3$) is also presented.

	Nitrogen.	Ammonia.
Winnekeni farm, per cent., . . .	0.56	0.68
Plaistow, N. H., " "	0.31	0.37
Boxford, Mass., " "	0.50	0.61

The above is as found in the *wet* condition. In the *water-free* state, it stands as follows:

	Nitrogen.	Ammonia.
Winnekeni farm, per cent., . . .	2.47	3.07
Plaistow, N. H., " "	2.13	2.58
Boxford, Mass., " "	2.12	2.57

The average of fifteen determinations of nitrogen in wet mucks, by Prof. Johnson, is	0.42
Water-free, ...	2.31

It will be noticed that Prof. Johnson's determination shows a little higher percentage of nitrogen in the dry muck than those which I have presented, but the difference is trifling. Taking muck-beds as they are found in the Northern states, it will be safe to assume that they hold, on an average, in the absolute dry condition, about two and a quarter pounds of potential nitrogen in each one hundred pounds.

The following table gives the results of the analysis of five specimens of muck, showing the amount of water, organic matter, and ash contained in each:

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Water,	77.36	85.49	76.46	89.35	36.74
Organic (vegetable and volatile matter),	19.65	14.39	22.97	9.64	5.30
Ash (including sand),	2.99	0.12	0.57	1.01	57.96
	100.00	100.00	100.00	100.00	100.00

In No. 5 will be noticed a very great dissimilarity of composition from the others. This specimen was taken from the bare bed of Plug pond in Haverhill, Mass., and in appearance is densely black, fine, and "well calculated to deceive." From this bed a neighbor had taken many hundred cart-loads, at great expense, for use upon his farm. It is a specimen typical of usual pond deposits, which are largely employed in agriculture all over the Northern states. They are worthless specimens.

No. 1 is the sample from my farm, from which the nitrogen determination was made, as given above. The amount of lime contained in the ash (not given in table) is 1.7 in the dry state. It is fully decomposed, dark, and every way of excellent quality.

No. 2 is the sample from Plaistow, N. H., and contains a less amount of water, a larger percentage of ash and organic matter than No. 1, but is of superior quality.

No. 3 is from Boxford, contains about the same amount of water as No. 2, much less ash, and more organic matter. The nitrogen contained in the last specimens has been given above.

No. 4 is from a large basin called "Sour Meadow," on the margin of Lake Kenosa, in Haverhill, Mass. This specimen holds nearly 90 per cent. of water, and has but 1 per cent. of ash. It is not well decomposed, having fragments of leaves, grasses, etc., in the mass. The five samples have been selected with the view of presenting the extremes of variation in muck-beds which are drawn upon by New England farmers for agricultural purposes. It is now possible to present a clear estimate of the value of the nitrogen in the best specimens. No. 1 from my farm meadow contains in each ton (2000 pounds) of *water-free* muck 4,940 pounds: this, at fifteen cents (a fair price), gives a money value of $7.41 for the nitrogen. The value of all the mineral and nitrogenous plant-food it contains may be stated as follows:

Nitrogen,	$7.41
Lime,	.30
Other salts,	.10
	$7.81

The cost of procuring one ton of absolutely dry muck may be undestood from the fact that *ten tons* of the wet mass is required, estimating the water at 90 per cent., which is a fair average for successive seasons. A ton of wet meadow muck of best quality is thus shown to have a value of seventy-eight cents as fertilizing material for farm crops, estimating its mineral plant-food constituents as we estimate that found in cow dung.

ANALYSIS OF COW MANURE.

With the view of affording a comparison of muck with fresh dung, a sample taken from my barn stalls, the droppings from cows in milk, is here presented. It contained of

Water,	81.08
Organic matter,	15.96
Ash,	2.96
	100.00

The result of this examination may appear somewhat startling, inasmuch as it shows that the fresh cow dung from the barn contains *more* water and *less* organic matter and ash than is found in the muck on the farm forty rods distant. It would appear (other things being equal) that the muck is as valuable as the dung, or even more valuable; but important considerations come in to dispel this illusion. A complete analysis gave, as contained in each ton of the fresh dung, the following amounts of valuable constituents:

Nitrogen,	5.11 lbs.
Phosphoric acid,	3.55 "
Potash,	2.00 "

The nitrogen in manure has a higher value than that in muck, but estimating it the same, with the phosphoric acid, potash, etc., the value stands as follows:

5 1-10 lbs. of nitrogen,	15	.76
3½ lbs. of phosphoric acid,	12	.42
2 lbs. of potash,	7	.14
Lime and other salts,		.33
		$1.65

ANALYSIS OF LIQUID EXCREMENT.

The nitrogenous and mineral value of muck stands to fresh cow dung as 78 cents to $1.65 per ton, water-soaked, or nearly three to one in favor of the latter;—but it must be remembered that fresh cattle-droppings do not represent *manure* as found in farmers' barn cellars. This consists of a mixture of the *liquid* excrement with the solid. A ton of fresh urine, as determined in analysis from specimens collected at my barn, gave the following results:

Nitrogen,	17-5 lbs.
Phosphoric acid	10.12 "
Potash,	15-9 "

This result indicates the very high value of liquid manures, giving a value per ton of about $5, the estimate being made in accordance with that for muck and for solid excrement. A ton of well mixed manure, containing equal proportions of the solids and liquids, has a money value of not far from *four dollars*, or this is the value of the manure stored in the barn cellar at Winnekeni farm, as learned from analysis.

MUCK HUMUS.

Let us look for a moment at the nature and value of the naked *muck humus*, that is, what remains after the separation of the nitrogen and salts, and contrast it with exhausted manure. The humus, or "geine," as Dana persists in calling it, which results from the decay or *mouldering* of vegetable matter *under water*, or in moist places, is a very different substance from that which results from the decay or decomposition of hay and grains in passing through the digestive and assimilating organs of animals. It must be admitted that muck very rarely represents merely the mineral constituents of the plants from whose remains it has been formed, neither does its organic portion represent

those structures, as when changed under other or usual conditions. In virtue of a kind of dialysis or chemical reaction, not only mineral constituents are changed or abstracted, but vegetable tissues undergo a metamorphosis which renders the changed mass not so well suited as other varieties of carbonaceous material to form fertile soils.

Hay and other forms of food consumed by animals in passing through living organs have their elements so acted upon that they speedily pass into putrefactive fermentation, which breaks down tissues or cellular structures with great rapidity. The catalysis of life impresses a peculiar power upon animal foods, and introduces a force of disassociation not noticed in other processes; hence *manure* has properties not found in any substance adapted to the nourishment of plants. Muck humus and dung humus can only be contrasted to the advantage of the latter. The former resists change (necessary change) when applied to silicious soils; and when muck humus is mixed in association with manure, the former is distinguishable on fields often for several years after the latter has gone from sight. In any just and accurate estimation of the comparative value of muck and manure, this important factor must not be lost sight of.

FARM TRIALS OF MUCK.

To present in detail the observations and experiments upon muck made at Winnekeni farm in the past quarter of a century would require space only afforded by a large volume. In this paper a brief outline or summary is presented. In trials of muck upon the farm, a systematic plan has been adopted, with the view of securing reliable results; and these show that *muck is not manure* in any proper sense in which that term is used. They further show that the substance cannot be made into manure without an expenditure for added materials, and at a cost of time and labor, which do not comport, under usual conditions, with proper farm economy. The simple mixing of lime with muck betters its condition, but it does not change it into manure.

If muck in its partially dried condition is to be changed into a mass corresponding in some particulars with manure, not only lime, but nitrogenous salts, potash, soda, soluble phosphoric acid, and other less valuable forms of plant-food, must be added.

I have succeeded in forming artificial manures at the farm, using muck as a bulk basis and absorbent, which afforded very gratifying results when applied to growing crops; but the cost arose, in all cases, in due proportion to its value.

In these experiments, the material in hand to begin with, muck, had a certain known value, and it would be manifestly empirical to expect from the use of that material benefits which it had not the power to bestow. In trials upon fields, in most instances, I have not learned that the raw material, air-dried or wet, gave results in increased fertility corresponding with expenditures incurred in its application. On dry, silicious soils it has not supplied the place or served the purpose of natural upland humus. On medium low lands, it has rarely indicated, through successive seasons, any influence for good.

MUCK MEADOW EXPERIMENTS.

A portion of the farm meadow from which muck has been taken was reclaimed and drained a dozen years ago, and nearly a thousand loads of sand carted upon it. This afforded for several years heavy crops of upland grasses; but, like all muck meadows, it requires applications of fertilizers to maintain fertility. The surface soil of a muck meadow is, from obvious reasons, better adapted for plant sustentation than the contents deeper down. Portions of the bog were turned up to light and air from depths of a foot or more, and on this, without sand or fertilizers, potatoes were planted. The crop was a failure, although the season was favorable. Root crops, the cereals, and even the better grasses do not flourish on a deeply ploughed muck meadow, so far as my observation extends; and there is, indeed, no reason to expect different results. These crops all require potash and phosphoric acid for complete development, agents which are not present except in minute quantities in any muck field. Experiments with muck soils upon all kinds of plants in pots, carried through several seasons, have supplied interesting facts, but the statements regarding them must be left for another paper and another occasion.

VIEWS UPON THE VALUE OF MUCK.

The laboratory researches upon muck undertaken at my farm, of which a brief and imperfect account is here presented, correspond essentially in result with those of Prof. Johnson, and all other chemists at home and abroad who have entered upon like labors. Such, however, is not uniformly the case with the practical use of the material by farmers in the field. A large number of quite intelligent men declare its influence in the direction of soil improvement to be marked and decisive. Others are so loose and extravagant in their statements of benefit received as to render them of very doubtful accuracy. Nothing is more deceptive and uncertain than observations upon farm crops, and the influence of soils and fertilizers, when no careful methods and no weights and measures, are employed. The eye, used only in a casual way in the hurry of farm work, is not a safe guide. Much of the confusion and uncertainty in which practical husbandry is involved is due to hasty, careless, unmethodical observations in the field. Better methods and more care are desirable.

CONCLUSION.

To sum up the whole question of the agricultural value of muck, it may be said that it is of great value as an absorbent of liquid manures, and where it can be obtained easily large stores of air-dried muck should be secured and used by every farmer. As an application *alone* to soils of any variety, silicious, dry, humid, or any other, it has a very small value. Its whole contained amount of mineral plant-food does not equal in value more than fifty or sixty cents a ton, and the bog humus in which it is involved is of little value except as an absorbent.

SUNSHINE ON THE FARM.

BY JAMES R. NICHOLS, M.D.

The farmer, above all others engaged in industrial pursuits, should be an intelligent student of nature. He should love to study the laws under which the whole machinery of the organic and inorganic worlds is acting. He should become better acquainted with the secret forces which exert such stupendous changes in matter, and which are so intimately connected with vegetable growth and decay. It is not enough that the farmer studies methods by which increase of crop results is secured; it is not enough that he learns to feed his animals under conditions which give the highest pecuniary returns; it is not enough that the best varieties of fruits are produced in his orchards: he should study the nature of the energies and forces by the movement of which his labors are crowned with success. I have alluded specially to silent and unseen agencies, and to this class belong the energies of the sunbeam. Without sunshine on the farm, all the labors of the husbandman are abortive and fruitless. We may fancy to ourselves conditions where sunlight might be replaced by artificial means. Let us bring to view a farm where the fields are rich with the best forms of plant-nutriment, where the rain falls in desired measure, where warm winds diffuse a genial and pervasive heat, but where the sunshine never comes. We may light up the broad acres with electric lamps, so that they are illuminated as brilliantly as the streets of our great cities; but with artificial light, the most potent that man can invent, the fields would be practically valueless, and successful husbandry abortive.

The experiments of Dr. Siemens in 1880, in the employment of the electric light as a substitute for solar light in stimulating

vegetable growth, would seem to show that it may be successfully substituted under certain conditions. His experiments led to the following conclusions:

1. That electric light is efficacious in producing chlorophyl in the leaves of plants, and in promoting growth.

2. That an electric centre of light equal to 1,400 candles, placed at a distance of two meters from growing plants, appeared to be equal in effect to average daylight at this season of the year, but that more economical effects can be attained by more powerful light-centres.

3. That the carbonic acid and nitrogenous compounds generated in diminutive quantities in the electric arc produce no sensible deleterious effects upon plants enclosed in the same space.

4. That plants do not appear to require a period of rest during the twenty-four hours of the day, but make increased and vigorous progress if subjected during daytime to sunlight, and during the night to electric light.

5. That the radiation of heat from powerful electric arcs can be made available to counteract the effect of night-frost, and is likely to promote the setting and ripening of fruit in the open air.

6. That, while under the influence of electric light, plants can sustain increased stove-heat without collapsing,—a circumstance favorable to forcing by electric light.

7. That the expense of electro-horticulture depends mainly upon the cost of mechanical energy, and is very moderate where natural sources of this energy, such as waterfalls, can be made available.

As we look out upon our farms, let us call up before us the working-forces which are building up the plant-structures in our fields. If the day is one in midsummer when the sun shines brightly, and moisture exhales from the odorous soil, we cannot avoid a feeling of exultation and wonder as we gaze around us, so active and energetic are the forces which are at work in building up cell upon cell in the grain and grass plants. On such a day I have frequently turned my ear to listen, expecting to hear, and even imagining I could hear, the hum of the busy workers as their gigantic labors go forward. Consider the fact that hun-

dreds of tons of water are lifted by millions of little pumps in the cellular tissues of the great trees in yonder forest! Think of what is going on in that cornfield which stretches away to the meadow!

So constant and unceasing is the work going on under the influence of solar light, that each individual cell resembles a hive of bees in the height of the honey-harvest. Each molecule of rich material needed to build up and perfect the separate parts,—whether it be the leaf, the blossom, the shining silk of the ear, or the kernel itself,—finds its appropriate place, and no mistakes are made. The water which holds in solution the mineral constituents—potash, phosphoric acid, lime, and silica—is started on its rounds by the greedy appetite of the spongioles springing from the roots; and the volume which is lifted and exhaled is immense. Work, work, work! All nature seems intent upon constructing and developing. There is intense activity in the air as well as in the soil; and behind this press and hurry there must be some producing cause, some force or forces which carry forward and sustain this mighty work. We have not to go far to find it: it is in the sunshine which falls so noiselessly and copiously upon the glowing fields. The earth is not the source and possessor of its own life forces. The high power which gathers dead matter into living structures, and calls into existence all the beauties and glories of the earth, is not of our world; it is super-terrestrial; it comes from the great central body of our planetary system, the sun.

Before directing attention to the nature of the solar beam, and the service it performs in clothing our fields in vestments of surpassing beauty, I must bring to view the great orb itself, and consider some of its physical and chemical peculiarities. If the question is asked, What is possible to be known of a body ninety-two millions of miles distant from our earth? I reply, We know very much regarding it. Our knowledge is as positive and demonstrable relating to the physics of the sun as that relating to the nature of many terrestrial bodies. A considerable number of rather intelligent persons doubt as regards our knowledge of the distance of the solar orb; they doubt if assumed knowledge of stellar worlds and distances has any basis of fact to rest upon. The man who did more than any other to

awaken respect for astronomical science among husbandmen was not an astronomer, but an almanac-maker.

If there was any one individual whose learning I regarded with profound respect in my youthful days, it was Robert B. Thomas, that mythical man, who, although declared dead half a century ago, still continues to make almanacs just the same. When he demonstrated fifty years ago, in that useful little annual, the *Old Farmer's Almanac*, his ability to prognosticate eclipses, the time of the rise and fall of tides, changes in the moon, and, above all, changes of the weather, without the use of the hateful word "probable," he silenced all cavil and doubt of the capabilities of science, and compelled his readers to believe what they could not comprehend. The old almanac magician is still a favorite authority; but I have to confess that my confidence is shaken in his weather forecasts since I was told by one who represents him in terrestrial life (who bears a name familiar to this board of agriculture), that he no longer superintends the weather predictions, but has turned that department over to his wife, whose forecasts are more popular.

We obtain clearer conceptions of the enormous distance of the central luminary from our earth by a consideration of the time necessary for some moving bodies with which we are familiar to make the journey.

If the railway train which brought us to this city could have gone on at the rate of forty miles an hour toward the sun, without stops for fuel and water, it would not have reached its destination until the year 2246. The trip would have continued three hundred and sixty-three years. If a human being could be projected from the muzzle of one of our eighty-ton guns, and fly at the usual speed of modern projectiles, the child born at the instant of the discharge would be nine years old before the voyager reached the solar orb. If we were in telephonic communication with beings at the sun, and a question was asked of one at the other end of the wire, the questioner could eat his breakfast while the question and answer were on the way. If the explosion of Gen. Butler's famous powder-ship, which occurred during the war, could have been heard at the sun (I doubt if it was), the sound did not reach there until 1876, twelve years after the close of the war. Light from the sun, moving

at the rate of a hundred and eighty-five thousand miles in a second of time, reaches us in about eight minutes. It is across this tremendous chasm the sun exercises his power. Every pulsation of the solar surface is instantly responded to upon the earth.

In bulk it is a globe having a diameter of eight hundred and sixty thousand miles, and it would take one million and a quarter earths to make a globe of equal size. The temperature of the sun is exceedingly intense. If we heat a cannon-ball to redness, and place it in the focus of a concave mirror, the rays of heat collected and condensed by another mirror ten feet away will be hot enough to ignite phosphorus, a very inflammable body; but, if a lens only three feet in diameter be used to concentrate the sun's rays into a focus, the heat is so intense that the most refractory solids are instantly melted or dissipated in vapor. Platinum, fire-clay, and even the diamond itself, are fused, or changed into gaseous conditions, if they are exposed to the sun's heat at a distance from it equal to that of the moon from the earth; and therefore, if our earth should fall towards the sun, it would melt, or pass into the liquid or gaseous condition, when as distant from the solar surface as the moon is from the earth. The intensest artificial heat that can be produced reaches perhaps 4000° F. It is difficult to ascertain the exact temperature of the sun by any measurements here; but it is easy to measure the *quantity* of heat emitted.

The sun in the zenith, shining upon the earth, emits sufficient heat every two hours and twelve minutes to melt a layer of ice one inch thick over its whole surface. To produce this effect by the burning of coal would require a layer thirteen feet thick all over the sun to be consumed every hour, or two thirds of a ton per hour to every square foot of surface. Such a fire as this no earthly furnace can parallel. At this rate, if the sun were made of solid coal, he would burn entirely out in six thousand years. These facts afford us some faint idea of the heat-energy developed by our great central luminary. As a practical question, you may ask, What is the amount of heat which falls with the sunshine upon our farms? If we take Joule's estimate of the mechanical equivalent of heat, which is probably correct within one per cent., and apply it to the solution of the problem, we obtain an approximative answer.

At the earth's equator, in the regions watered by the Amazon in South America, the earth receives from the sun sufficient heat every year to raise fifty-three tons to the height of a mile. On our farms in New England, if the heat of our summer months was continued the year round, its aggregate would not fall much below that of the tropical regions. During our cold winters our farms are covered with snow and ice, and the sun's warmth is expended largely in the liquefaction of this covering. We must not forget the paradoxical fact, that now, upon the threshold of our winter, when the days are shortest and the cold most severe, the sun is nearly three million miles nearer to the earth than in July last, when the heat was at its maximum. The obliquity of the sun's rays gives us winter, not his distance from us.

The heat that falls upon our farms is disposed of in various ways; but it is largely used in maintaining the earth's temperature, as vast quantities are radiated into space. Of the immense amount received, it is probable that not more than one thousandth part of the whole is stored up in our crops and animals, or consumed in labor. This estimate being approximatively correct, how wonderful that this minute fraction is an abundant revenue of power for the whole human race!

Do we clearly enough comprehend the fact that in the sunlight which is shed upon our farms we find the source of every form of force or energy that comes under observation? Let us briefly consider this most interesting subject; and, to render lucid the discussion, I will present a few interrogatories. What relation does sunlight sustain to the work performed by our oxen and horses, or by ourselves in our daily labor? Work, labor of any kind, is the manifestation of energy, and it depends upon chemical action,—upon the oxidation of substances in the body of man or animal. In the stomach are placed certain substances which are capable of being burned or oxidized: they are called foods. Organized substances, like corn, wheat, potatoes, etc., are made of dead, inorganic materials by the force of solar light and heat acting upon the soil and air. Out of the dead material in our soils, and out of the dead carbonic acid in the air, living plants are produced by the solar rays. Dead material is like a watch-spring run down so that the machinery stops. Sunlight

winds up the coiled spring by forcing molecules to combine so as to form vitalized structures; and when the substance of the structure is consumed as food, the force of the spring is expended, and is manifested in muscular labor. It is seen, then, that it is sunshine upon our fields which supplies the muscular forces of our animals and ourselves, and that from no other source is it derived. The contents of our barns, granaries, and cellars are in a proper sense but stored sunlight,—sunlight which we have economized in the summer from the excessive supply. Whence is the power of the windmill, that pumps the water for the barn and dwelling? the steam-engine, which threshes the grain and cuts the succulent corn for the silo? Whence that of the mill that grinds the grain, propelled by the stream that comes from the hills? All these sources of power are related to sunshine, and the dynamical forces are derivable solely from the solar orb. Its heat, acting upon currents of air, expanding its volume, gives rise to winds which move the arms of the mill. The steam-engine is moved by heat resulting from the combustion of coal or wood, which are the products of organization. Our coal-fields are but *cachets*, holding the fuel pemmican, stored by natural agencies, and designed for the use of man when large supplies of fuel would be needed. Coal may be regarded as the sunlight of a past epoch utilized at a period when man had no wants, for he probably did not exist. The grist-mill on the stream must come to a stand-still when clouds no longer form, and condensation of the moisture, raised from oceans, rivers, and lakes by solar heat, is suspended. Every molecule of water which weighs upon the mill-wheel has been acted upon by sunshine, and, by its agency, placed in position for useful work. In whatever aspect we regard the solar emanation, it presents itself to us dynamically, as a spring of power. Whichever way we turn, we find all is motion, activity, demonstration of force. The atmosphere surges in storms and hurricanes; streams thunder over precipices; steam urges on the dilatory ship, or impels the factory; electricity carries intelligence to the world's ends; the animal world is everywhere in motion, cleaving the air, dividing the waters, burrowing in the earth, traversing the land, and putting forth power in countless forms. Yet the placid and tranquil sunbeam does the work. It is the great dynamical

energy of the world. It may be interesting to consider how much working force a farmer derives from the sun through the medium of foods. From the most careful computations, based upon the known mechanical equivalent of heat as connected with the different forms of food, it may be stated that a working-man on the farm produces in twenty-four hours an amount of heating or thermal effect equal to raising fourteen million pounds to the height of one foot. He is not, however, capable of producing in actual work on the farm mechanical effects of that magnitude. A healthy farmer, in the busy season of summer, is capable of exerting every day, in his work, mechanical results equal to raising three million six hundred thousand pounds to the height of one foot. This statement seems astounding, but it is based upon scientific data which are approximately correct. Follow the man in the haying season, and consider the constant expenditure of force in walking, mowing, pitching, raking, and even in breathing and eating. Two or three tons of hay pitched from the ground, through a distance of eight or ten feet, to the top of a load, requires a mechanical force, which, when accurately computed, is found to be great. The wide range between the heat-energy which a working-man produces, and that which he is capable of utilizing in labor, may seem surprisingly large; but we must remember that throughout nature there is a prodigality of force manifested, and it is apparently impossible to cause the whole which is developed in any one form to be made subservient to the uses of man. We burn coal and wood for household warmth and for mechanical purposes, in devices or under circumstances the best which ingenuity can invent, and yet we know we do not utilize but about one eightieth part of the energy which is liberated. In man, the heat and nervous force which come from the solar ray are largely dissipated through the functions of the skin and lungs; and in burning fuel the great mass of the heat is lost through flues and imperfect combustion. Chemical change which results in unlocking the energies of the sunshine may proceed so slowly as to be insensible in its effects upon man, as in the rusting of metals, or in the slow decay of wood; or it may be so rapid as to utterly escape control. The stored sunshine in our barns, in the form of hay and grain, is, in its utilization, attended by losses corre-

sponding with those connected with change in other forms of organized material. In modern barns, properly constructed, we are astonished to find how comfortable the temperature is when we enter them on the cold mornings of winter. It may be difficult for many farmers to realize that this warmth all comes from the contents of their hay-mows and grain-bins,—from actual burning or combustion of these nutrient materials. The long rows of cows and oxen in the stalls may be properly likened to an arrangement of little stoves in which the products of the summer fields are burned, each animal representing a stove of greater or less capacity, according to the size. This burning is not spoken of in an ideal or poetical sense: it is actual, positive. Every load of hay which the husbandman takes to his barn from his fields in July or August is to be burned up in winter; and the exact amount of heat which would be afforded by its active combustion in the field is to be gradually eliminated from his animals in cold weather. And further: the amount of heat liberated must represent in its energizing capabilities the solar energy consumed in the growth of the grass or grain. In other words, the number of increments of heat made sensible in the organization of a cow by the consumption of one hundred pounds of hay, exactly represents the number of increments of heat in the sunshine which produced that quantity of forage. The food energies of a cow are not all expended in producing animal warmth; a considerable portion goes toward the milk-pail: and all the sunshine of our fields that we can utilize in the cow is the milk-product, and the adipose tissue resulting from the fattening process.

The warmth which we experience in our barns in winter is, to a considerable extent, wasted heat-energy; it is the surplus heat generated by the animals, and which is radiated into space through the respiratory and excretory organs. We diminish this radiation of heat when we give a bucket of cold water to each animal, as is often done in the morning; and the diminution of warmth, in a barn where there is a large number of animals, is so great that the thermometer is sensibly affected. The same results are reached when water is thrown upon a hot bed of coals. It requires the same expenditure of heat to raise one hundred gallons of ice-cold water to the temperature of 90° F. in the

organisms of a herd of cows that is required to raise the same to like temperature by the fires in a farmer's kitchen. As wood and coal are cheaper products than hay and grain, it follows that it is a matter of economy to warm the water supplied to milch cows in the winter season. I but give voice to the experiences of observing farmers, when I assert that three gallons of water at the freezing temperature, given to a cow in winter twice a day, will cut short the milk-product more than six per cent. in twenty-four hours. The chemical energy requisite to produce milk cannot be diverted to heating water in the system of the cow without serious loss.

At this point several interesting inquiries arise. Since it is seen that all forms of energy possible upon our earth result from the sun's rays, what maintains this tremendous furnace, the sun? What is the fuel? How long has it blazed as now, and when will it be extinguished? These are questions which cannot be answered with any satisfactory certainty. There are reliable data, however, which enable us to know with a great degree of positiveness that the farmers of two thousand years ago received as much heat from the sun as we do now, and that their vines and cereal crops flourished in great luxuriance. The amount of heat received from the sun has not materially changed in the lapse of 2,000 years. Geological facts show that for millions of years there have been alternations of heat and cold of great intensity. They show that there has been enormous activity in vegetable production; and then came ice, which covered the earth's surface, except spaces along the line of the equator. We have no absolute knowledge whether the sun is growing hotter or colder, but it is probable that at present it is receiving as much heat as it throws off into space, and there is no occasion for alarm as to a failure of the supply.

As regards the nature of the fuel of the sun, we have no positive knowledge. Inquiries in this direction are beset with difficulties. There are nearly as many theories as there have been distinguished astronomers and mathematicians. It may be due to meteoric matter raining upon the sun's surface, or it may be a peculiar universal atmosphere through which the sun is passing, or it may be that no fuel (in any sense in which that term is used by man) is needed by the great central orb. It is

quite possible to conceive of a body losing heat for ages without changing its temperature, although changes go on in the molecular constitution of its materials. There must, however, be an end to the sun. Its final extinction cannot be a matter of doubt, but at our epoch we need not give ourselves any anxieties on that account.

If asked as regards the chemical processes going forward at the sun, which result in the evolution of the stupendous quantities of light and heat received, I would say that no processes known to our chemistry are adequate to explain the problem. The hottest of all our chemical changes or combustions are as ice currents compared with the heat of the sun. It cannot be that any processes corresponding with what is known among us as combustion can occur at the sun, or, at least, they fail to account for observed phenomena upon the solar disk. The heat of the great blast furnaces of Pennsylvania, which rapidly fuse thousands of tons of refractory iron ore, is but that of the wax candle when placed in contrast with the heat of the sun. Its light is so intense that if we arrange one of our electric arc lights in a way so that it may be projected upon its disk at noonday, it forms a dark spot, destitute of luminosity. The spots seen on the solar surface, and upon which a vast amount of research has been bestowed, appear like dark patches, or like clouds in the terrestrial atmosphere, floating from the sun's equator towards its poles. These spots are of vast extent. During the past summer one was examined at my farm with a Tolles five-inch objective, which was more than 100,000 miles in diameter. If our earth had suddenly fallen into the sun, striking upon this dark spot, it would have passed through the cloud without causing any special disturbance, or certainly not enough to have been noticed by astronomers at the distance of our planet from the sun. We must not suppose that these spots are destitute of light, for the brightest artificial illumination we can produce is but darkness in comparison with these sun clouds. When floating in the solar atmosphere they seem dim by contrast with the brighter effulgence which emanates from the luminous ocean outside of them.

The sunshine which falls upon our farms is seen to be an influence of exceeding complexity, and of wonderful capabili-

ties. Its power is not alone due to the heat which accompanies the solar beam, but the light is potent in its influence upon soils and plants.

From what has been presented in this brief and imperfect study of the solar beam, we are compelled to look upon the vegetation of our farms as a stock of deoxidised carbon and hydrogen prepared by the sun for the sustenance of animals, and for the use of man as a source of warmth and mechanical and chemical power. However we may regard the cereals, grasses, and roots which we so assiduously cultivate, they are but little masses of stored-up force, wholly due to the influence of summer sunshine, and all the skill which is called into exercise in their production results only in removing obstacles, and brings within the influence of solar light and heat agents which aid them in their work.

We attach great importance to what are known as fertilizing substances, and we are apt to think we are dependent upon them for success upon our farms. They are at best only indirect aids. They are molecules of inert matter, which, when brought under the influence of sunlight, made subservient to its chemical power, are forced to assume higher positions, and become integral parts of vital structures. The great end of all work upon farms is to aid sunlight in promoting those changes which cover our fields with herbage, so that men and animals may exist in the season when the sun is incapable of shedding upon some portions of the earth its full measure of light and warmth.

It is only on the surface of the earth that the influence of the sun can be exerted, and it is apparent that if our planet was a fixed orb only a part of its surface could be inhabited; but, in accordance with the great plan of creation, the ponderous globe revolves rapidly upon its axis, and each portion of its surface receives a share of solar influence. All the movements of nature are brought into play only in an appointed way and by appropriate mechanism: there is no disturbance in her mighty movements.

The position which the laboring farmer occupies is that of a director of forces. He is not an originator: he possesses no creative power. We observe upon two farms, occupying positions side by side, that the products of one are double those of

the other; and this arises from the circumstance that one farmer is a better student of nature than the other:—one has learned how to aid sunlight in its work; the other makes no inquiries, wishes for no instruction, and the forces of nature, so active all around him, receive no intelligent guidance, no aid. The light that falls upon him and his acres might as well be that of the moon,—a borrowed effulgence, devoid of life-giving power.

It has been stated that the two worlds of organization are condensed from the unseen gases with which our planet is surrounded. If living beings are derived from these fleeting airs, which are so rare and etherial, may not this indicate that there is a connection between matter and spirit, and that the forces which control such wonderful changes have a celestial origin? We have in the element oxgyen an agent which locks up in unchangeable forms all the products of our fields, the organizations of our animals, our houses, barns, our tools of wood, iron, and steel, all vitalized products of our earth, including our own bodies. If this agent, which has the power of pursuing to its final dissolution the entire organic world, when called up before us by the sorcery of the chemist proves to be a gas which cannot be seen, tasted, nor felt, it cannot surprise us that the force of antagonization, by which all beauty and glory upon the earth are perpetually called into being, should be the divinest affluence which can come from above—the gentle sunshine, glorious in all its attributes.

The sun is but a star: the fixed stars are also suns, many of them being a thousand times larger than our own. Their light comes to us from the profoundest distances in space. The light from the nearest fixed star occupies a little more than three years in reaching our earth, and yet, as has been stated, it travels with the incomprehensible speed of 185,300 miles at every tick of the clock. The light that beams upon us this evening from the dog star, Sirius, left that distant orb in 1879, and we have gathered into our barns the crops of four seasons since it started on its way. These allusions to stellar light are made as preliminary to the statement that the light of the stars is identical with that which comes from the sun. Luminous impulses, which expend themselves upon the retina of the eye in a few minutes after they have left the central orb of our system,

affect the brain in exactly the same way as those which have been many thousand years travelling from the uttermost bounds of the telescopic universe. The stellar light has the same chemical effect as solar light. It comes under the dominion of the spectroscope, and affords lines and shadows corresponding with sunlight in many respects. If stellar light was abundant, and accompanied with heat, its actinic effects upon the vegetation of our farms would result in the growth and full maturity of crops. Upon how many farms on distant spheres this light falls, arousing dormant energies, and bringing to view the useful and the beautiful, we do not venture even to surmise.

Our sun we know to be the great centre of vital dynamics and fountain of life impulsions, and it has charge of the destiny of our planet, alike its masses and its atoms. If it be but a solitary star among the countless hosts of the celestial spheres; if the earth be a scene of life, beauty, and intelligence only by virtue of its astronomical relations; if the messenger of the Deity, the solar beam, comes through the spacious amplitudes 93,000,000 of miles to illuminate, vivify, and people an otherwise desolate globe; if the life-exciting forces traverse stellar distances, and belong to astral systems,—can we imagine even for a minute that the phenomena of life are limited to our earth? Can there be a question that organization is the product of a plan of agencies which comprehends the physical universe, and that the effect must be as universal as the cause?

THE GRINDSTONE.

CONDENSED BY THE SECRETARY FROM A PAPER PUBLISHED BY J. R. MITCHELL, OF PHILADELPHIA.

THE ANTIQUITY OF THE GRINDSTONE.

In the whole range of mechanics, with all modern developments and enlarged capabilities, there has been applied no mechanism nor process yet able to supersede the grindstone in its peculiar office. It is the one thing in mechanic arts that improvement has not added to, or invention displaced. While the pruning-hook and plow are of equal antiquity, the spirit of improvement has touched both, but left the grindstone unchanged. Its utility in the early ages was great, and science has not lessened its value by its perfection of other means for like results. It has been found in use among uncivilized peoples, and yet has its place with nations most advanced.

Writers of fiction knew it would not conflict with the appearance of truth to ascribe it a place among barbarians. It is among the few implements of handicraft mentioned in Scripture, though there only named for milling purposes; it is the same in form and in universal use—a round revolving stone. In a Scriptural research for the articles of handicraft mentioned then, we can look through the "eye of a needle" and find the grindstone beyond, its origin lost in the darkness of antiquity. It is not meant to confound the mill-stone of antiquity with the grindstone of to-day, which the encyclopedia mentions as "a flattish circular stone of various diameters, employed in the cutting and sharpening of edge-tools, precious stones, &c., and

the grinding of steel, glass, pottery, and the like. They are made of sandstone, or sandstone grit."

The grindstone now has scarcely a wider capability or greater usefulness than when we first hear of it. Although limited as its qualifications may be, it serves its purpose as nothing else can. Improvement has furnished us wheels of composition which only to some extent serve some of its purposes, but the grindstone still remains unsupplanted. It is a tool of the utmost nicety, in proper hands and properly understood, and is capable of performing with speed and precision its limited agency, beyond the powers of any modern tool. It is perhaps found best handled in its purpose of grinding dies for cut nails, where its proper use constitutes an occupation not to be attained very perfectly by a short apprenticeship with it. That known as the "bead stone," used by makers of cut nails, is a tool of the utmost perfection of workmanship, not to be meddled with by the inexperienced, however lightly, without the result being noticed by the eye of the experienced nailer. The milling machine, the planer, the file, the lathe and emery wheel, do much of the work of the grindstone, but it still performs to perfection its needful, though limited, purposes. The importance and nicety of it, as a means to a purpose, is only known by those who know how to prepare and keep it in order.

Its utility or importance could not be guessed at, were one to look at a crooked and badly kept grindstone; but in the hands of those who know its merit, with its even surface running as true as any turned wheel, it will perform work with a rapidity and precision attainable by no other means. In the hands of those who are learned in its use and keeping, it is capable of adaptation to intricate and fine work; but with those who do not understand it, it is rude, and the very opposite of what the educated craftsman would select for any purpose of fine employment.

An heirloom of antiquity, but used among us as we received it, and without any attachment or improvement, capable of its complete functions only when well kept and well applied,—and this is only found with those whose craft-education is solely to handle it. It alone can cut and shape expeditiously that which is prepared to cut and shape all other hard materials—cast steel

hardened. It is still employed to give the finest edge, the most even surface, the brightest polish, and is the quickest to accomplish it. The emery wheel does but a few of its purposes, and nothing that we have could supply its place. The file has its own peculiar uses, but in contact with the grindstone, its thousand small cutting edges would be reduced to polished plainness. It is found a necessary implement on the farm, and is still required where the finest of instruments are made, or the hardest of metals are worked. It has come to us as we have it, and in all likelihood will pass on down to other ages the same—a simple circular stone, swiftly revolving on an axle.

It accompanies those who "go down to the sea in great ships," and moves along the frontier with the advance of civilization. All nations use it, and it is, perhaps, with all, the one piece of mechanism that bears the same form, and is the same in principle. More or less directly it takes part in the greatest modern material enterprises; it has, no doubt, assisted to fashion the implements of many of the lost arts, and is still needed in many of the requirements of the arts of the present day.

As ages revolve, and invention gives to the world new devices, may it be found more the agent in forming the plowshare and pruning-hook than in sharpening the sword.

WHERE GRINDSTONES COME FROM.

The sandstone formation overlying the coal beds of England furnishes the grindstones of that country, the principal quarries being located at New Castle-on-Tyne and at Wickersly. The quarries are worked by hand, and all the grindstones are made with mallet and chisel, and have been imported into this country for over one hundred years. The grindstones from the provinces of Nova Scotia and New Brunswick are, also, the overlying sandstone formation of the coal district bordering on the Bay of Fundy, and extending across the province to the Gulf of St. Lawrence. These immense deposits contain a great variety of grits known as Nova Scotia grindstones. These quarries are generally worked by the French people, known as Acadians, from the name they gave this country, "Acadia," and are the descendants of the Huguenots, who were driven out of France by religious persecution. They are a very industrious and sim-

ple-minded people, and the females retain to this day the style of dress brought over from France by their ancestors.

The tides of the Bay of Fundy rise and fall from sixty to seventy feet every twelve hours, and these people avail themselves of this power to work the quarries, which extend from a high bluff on the mainland down to low-water mark in the bay. At low water a huge mass of stone is loosened from its bed, and a heavy chain is passed under it and over a large boat which is placed alongside. As the tide rises, the stone attached to the bottom of the boat is floated into a sand cove at high water, and made into a grindstone after the tide recedes. This is done with mallet and chisel, the rough parts being first chopped off with a heavy axe. Machinery has been recently introduced, and the small grindstones are now turned in a lathe by steam power.

The sandstone deposits of this country, which are made into grindstones, are found along the shores of Lake Erie and extending for a considerable distance east and west of Cleveland, and inland as far as Marietta, on the Ohio. They are also found on the shores of Lake Huron, above Detroit. These deposits are of a different character from the foreign stone, and do not seem to be the overlying strata of coal formations, but appear to be a later formation, as the quarries look as though this part of Ohio had once been the bottom of the lake, the sand of which had become solid, and been upheaved by some convulsion of nature. Nearly all the Ohio grindstones are made by machinery driven by steam power.

The blocks of stone being loosened from the quarry bed, are roughly hewn out, with a square hole in the centre; they are then placed on a heavy square iron shaft, furnished with a nine-inch collar, against which the stone is securely fastened by means of another collar keyed against the stone. The shaft and stone being driven by steam power, two men on opposite sides of the stone turn it off perfectly true by means of soft iron bars six feet long, two inches by one half inch thick, which are drawn out to a thin point which is curved upward. This was formerly a very unhealthy operation, owing to the dust being inhaled by the workmen; but this difficulty is now obviated by means of blowers which drive it away.

THE USES OF THE GRINDSTONE.

There are specialties in mechanic arts which are the results of many years of practice, and in nothing more than in the varied and important uses to which grindstones are applied. Formerly their operations were confined to the sharpening of tools only; but this is now only a small part of the uses to which they are put, as it has been found by experience that almost every kind of steel, iron, and brass work used in finished machines can be ground better and cheaper than by filing. Almost every part of a locomotive engine is now finished on the grindstone, which leaves the metal in the best possible condition to receive the polish or paint in finishing. The Baldwin Works, Philadelphia, keep six grindstones of 4,000 pounds each running constantly on locomotive work alone, not only all the rough castings being ground, but forty-one working parts of the engine are finished in this way, besides grinding off the faces of their anvils, some of them weighing 700 pounds. The master machinists of nearly all the railway repair-shops find it to their interest to keep at least one grindstone in use for this purpose.

Grindstones are also used for finishing pulleys of all sizes. The pulley is caused to revolve against the stone, which runs rapidly in an opposite direction; this grinds down the face of the pulley very fast, and at less cost than turning it off in a lathe, besides leaving it perfectly true. It requires, however, a very peculiar grindstone for this purpose, the grit of which should be very sharp and firm, so as not to crush down with the necessary pressure, and yet not so hard as to glaze in using. A peculiar kind of Newcastle grindstone has been found to meet these requirements, and should be used with water to prevent heating.

MACHINISTS' GRINDSTONES.

There is probably no implement in the machine-shop or factory which pays better for the care bestowed on it than the grindstone; and when we consider that nearly every tool and all edge-tools require its use, it is somewhat surprising that more attention has not been bestowed on the proper selection of the grit for the purposes intended. The writer has frequently observed in many machine-shops that a good grindstone, well

hung and in perfect order, was the exception rather than the rule. As grindstones in such places are almost constantly in use, their first cost is of little consequence if the quality is calculated to do the work required in the shortest time and most perfect manner, as more time can be wasted on a poor grindstone, badly hung and out of order, than will pay for a good one every three months. This state of things should not continue, as with the great improvements made in the manner of hanging them, and the endless variety of grits to select from, every machinist and manufacturer should have a grindstone which will not only do its work perfectly, but in the shortest time. This can be accomplished by sending a small sample of the grit wanted to the dealer to select by.

Grindstones are frequently injured through the carelessness of those having them in charge. The machinist's grindstone will have a soft place in it, caused by a part of it being allowed to stand in water over night, and the difficulty arising from this cause increases with every revolution of the stone; but, as this homely implement is in charge of all the men in the shop in general, and no one in particular, and as all the workmen are too busy to raze it down, double the time is consumed in imperfectly grinding a tool than would be required to grind it perfectly if the stone were kept in order by some one whose duty it should be to attend to keeping all the grindstones of the establishment in order. The wages of a man for this duty would be saved in the time and perfection with which the tools of a large establishment could be kept in order for work.

FARMERS' GRINDSTONES.

There is no implement so essential, and no one to which so little attention is paid, as the grindstone. The worn-out and worse than worthless "hubs" of the neighboring saw or edge-tool factory, with a wooden axle, and set in the crotch of a tree, is considered, by some who know no better, as being all that is necessary to a farm in all other respects, perhaps, well stocked. But with the introduction of greatly improved agricultural implements, mowing-machines especially, the need has been felt for something better than these primitive arrangements; and in order to keep pace with this onward march, improvements have

been introduced, both in the grit and manufacture, as well as in the mode of hanging this indispensable article, which, perhaps, may be new to most persons.

The best grindstones are now made by machinery, which renders them mathematically true, and the grit being selected of only the best quality, the getting of a good one is reduced almost to a certainty. The ordinary square cranks have been superseded by those made on the self-adjusting principle, which consists of a round shaft on which a screw is cut, and two plates, which are screwed together with a burr, so as to suit any thickness of stone, which, by pressing against the sides of the stone, instead of the shaft being wedged into the eye, prevents any possibility of splitting the stone, while at the same time it causes it to hang perfectly true on the crank. Another improvement is in the use of friction rollers, thereby reducing the friction just one half, and enabling the farmer, with the use of a treadle, to grind any small tool without calling off some one from his work to "turn the grindstone." No grindstone should be exposed to the weather, as it not only injures the wood work, but the sun's rays harden the stone so much in time as to render it useless; neither should it be run in water, as the part remaining in water softens so much that it wears away faster than the other side, and many a "soft place" in a stone has arisen from this cause alone, and not from any inequality in the grit. The proper way is to allow the water to drop on the stone, as it is needed, from an iron water cup, or, what answers very well, an old white-lead keg, supported above the stone, with a spile near the bottom, which can be driven in when not needed, and if kept filled with water will last a long time. Finally, the stone should not be allowed to get "out of round," as no tool can be properly ground unless the stone runs true. If it should become uneven, get some one to turn it, and with a nail rod raze it down until it becomes perfectly round. Greasy or rusty tools should be well cleaned before grinding, or they will choke up the grit. If this should occur, a board pressed against the stone, and a little sharp sand dropped between it and the stone, while the latter is turning, will clean it off and sharpen up the grit.

HOW TO HANG AND USE THEM.

There is probably no appliance of the machine-shop or manufactory to which so little attention is paid as to the grindstone, and it is very rare indeed that this useful tool is found to be in perfect order. This is the more remarkable considering the great improvements made in the manufacture of iron and steel tools, on the perfection of which the precision and proper grit of the grindstone has a very important bearing. We propose to try to remedy this omission by offering some suggestions as to the selection of suitable grits, and the proper mode of adjusting, using, and keeping grindstones in order.

There have been very decided improvements made over the old style of fixtures for hanging grindstones, which generally consisted of a square shaft which was wedged into a square hole in the middle of the stone, at the imminent risk of bursting the stone when at rest, or of endangering the life of the grinder when in motion.

Before adjusting the stone on the shaft, the two sides should be made perfectly parallel, so that the flanges will bear evenly; then adjust the shaft. If the stone does not run true, the high side can be placed uppermost, and by gently unscrewing the nut and striking the stone, it can be made to drop the desired distance, which can be indicated by the flange. In our largest establishments the stones are turned off perfectly true outside of the shop, so as to avoid the dust which injures the machinery, and by leaving a depression in the sides of the stone of the size of the flange it will run true without further labor. After being thus adjusted, it should be kept true by the free use of the hacker, and should not be allowed to stand in water. A diamond carbon tool is used where great nicety is required, and the sides of the stone are painted (without the use of oil, however) in order to prevent the moisture from entering, and thereby keeping the edges square.

The following from the *Technologist* gives a good idea of the process of sharpening tools.

"Edge tools are fitted up by grinding, very much as a plank would be reduced in thickness were a large plane employed, in which were set a hundred or more very small gouges, each cutting a narrow groove. The sharp grit of the grindstone being

harder than the iron or steel, cuts very small channels in the surface of the metal, and the revolving disc carries away all the minute particles that are detached by the grit. If we were to examine the surface of a tool that has just been removed from a grindstone, under the lens of a powerful microscope, it would appear as if it were like the rough surface of a field which has been recently scarified with some implement which formed alternate ridges and furrows. Hence, as these ridges and furrows run together from both sides at the cutting edge, the newly ground edge seems to be formed of a system of minute teeth rather than to consist of a smooth edge. For this reason a tool is first ground on a coarse stone, so as to wear the surface of the steel away rapidly; then it is polished on a wheel of much finer grit; and, finally, in order to reduce the serrature as much as possible, a whetstone of the finest grit must be employed. This gives a cutting edge having the smallest possible serration. A razor, for example, does not have a perfect cutting edge, as one may perceive by viewing it through a microscope; and yet the serrations are actually so much smaller than a human hair that the minute teeth cut the hair in twain; but when the serrations on the edge of the razor become so battered up and dull that they will not sever a hair or cut a man's beard off, the edge must be honed and strapped until the system of minute teeth will be so much smaller than a hair that several of them will take hold of the smallest hair at once. These suggestions will furnish something of an idea of the operation in grinding and whetting edge tools. Beginners are sometimes instructed, when grinding edge tools, to have the stone revolve toward the cutting edge, and sometimes from it. When the first grinding is being done, this is a matter of indifference; but when the finishing touches are applied near and at the very edge, a grinder can always complete his task with more accuracy if the periphery of the grindstone revolves towards the cutting edge, as the steel that is worn away will be removed more easily. Whereas, when a stone runs in the opposite direction, the grinder cannot always tell exactly when the side of the tool is fully ground up to the edge. This is more especially true when the steel has a rather low or soft temper. The stone, when running away from the edge, will not sweep away every particle of the

metal that hangs as a "feather;" but when the stone revolves towards the edge, there will be no "feather edge" to deceive the eye of the grinder."

WHY DO GRINDSTONES BURST?

In olden times, grindstones were always made with a square hole in the centre, about six inches across, in which a square iron shaft was placed, and the stone adjusted by means of wooden wedges, driven around the shaft with sufficient force to hold the stone securely in its place, and to resist the power applied to the shaft when dressing the stone off. This resistance at the edge, being equal to a lever purchase of half the diameter of the stone, has a tendency to burst the stone by the pressure of the shaft in the eye of the stone, which is also frequently augmented by the swelling of the wood employed as wedges.

Bursting of grindstones was a common occurrence under these circumstances, happening sometimes soon after the stone was hung, but frequently after being weakened by wearing away a part of it. Grindstones are generally hung at nail works by means of two heavy cast-iron plates, with square holes and a heavy square boss cast on the outside. Four holes are bored through the stones near the corners of the eye, corresponding with the four similar holes in the plates, through which four bolts pass and fasten the plates securely to the sides of the stone by means of nuts. A square shaft passes through the centre of the plates, and the stone is adjusted by means of eight set-screws passing through the boss, and resting against the sides of the square shaft. This relieves the eye of the stone from any strain, but the tendency of the four holes in lines with the corners of the eye is to weaken the stone in these directions. A case occurred of grindstones having been burst by using cast-iron plates with a square boss four inches long, cast on the inside of the plates and tapering towards the end, which was fitted snug into the eye of the stone, and the plates being pressed against its sides, the tapering boss acted as a wedge, and two stones were burst in this way before the cause was discovered.

The best mode of hanging a grindstone is on a round shaft of wrought iron on which a collar is forged, with two cast-iron plates of about one third the diameter of the stone, and dished so

as to bear on the outside edge of the collar only. A screw is cut on the shaft, and fitted with a heavy nut, by means of which the two plates are pressed against the sides of the stone, holding it firmly by pressure and friction alone and relieving the eye from all strain. A stone hung in this manner should not burst except by centrifugal force, caused by the stone being run at a very high rate of speed; but stones do burst even when hung so, and when not running at a dangerous rate of speed. As the bursting of a grindstone is always fraught with great danger to the workmen using it, and in its vicinity, it becomes of considerable interest to know the cause. Grindstones vary very much in their composition, and in the manner in which their particles are held together. Some stones are composed of grains of pure sand, which have been pressed together with little or no cementing material, leaving numerous interstices among their particles. In others, the particles of sand are cemented together with clay, rendering the stone much more compact and strong. A stone of the first kind, being porous, will weigh less to the cubic foot than the latter, and will absorb more water when in use, thereby rendering it still less strong. The quantity of water absorbed by a stone of this character has been proved by actual experiment to be equal to 12 pounds to the cubic foot, while in the closer and more compact stones it is but 5¼ pounds, so that if a dry porous stone of 6 feet diameter by 12 inches thick contains 27 cubic feet, it will absorb 324 pounds of water when in use; and when such a stone is allowed to stand over night, a considerable portion of the water will settle in the lower half of the stone, while the upper being exposed to a free circulation of air, will lose its water by evaporation, and will be left comparatively dry, so that no matter how true the stone may be dressed, the effect, when in motion, will be the same as of a badly balanced fly-wheel, and with a little increase of the usual speed, the tendency will be, of the wet side, to fly off from the rest of the stone, or, in other words, to burst the stone. A case of this kind recently occurred in New Jersey. A workman had been using a stone of this character for grinding sad-irons. The stone being completely saturated with water over night, the following morning he started the stone (which was about six feet diameter by one foot thick), and, after working a short time, had occa-

sion to step aside for a few minutes, when the stone burst, a portion of it passing through the roof and lodging in the side of an adjoining building, another striking a heavy driving-shaft in front of the stone, and a third falling in the pit in which the stone was running. The usual speed of this stone was about 180 turns a minute, which it is supposed was somewhat increased by the absence of the grinder. The increase of the speed of an unequally balanced stone of a porous character caused it to burst. Great care should be exercised in examining a stone for defects before hanging it. This can be best done by washing off the sides and edge with water and a broom, and if any crack be discovered, the stone should be rejected. No part of a grindstone, as has been already stated, should be allowed to stand in water when not in use, as this would but increase the tendency to burst in the manner above referred to, besides causing a soft place.

The English, Nova Scotia, and Ohio grindstones are the principal kinds in use, but each of these sorts is subdivided into an endless variety of sizes and grits.

ENGLISH GRINDSTONES.

Newcastle. Yellow color and sharp grit; the fine soft ones for grinding saws, and the coarser and harder ones for sad-irons and springs, pulleys and shafting, and for bead and face stones in nail-works, and for castings.

Wickersly. Grayish-yellow color; for grinding saws, squares, bevels, and cutlers' work generally. A very soft grit to avoid taking out the temper.

Liverpool or Melling. Of a red color and very sharp grit; for saws and edge-tools generally. An excellent grit for sharpening axes in ship-yards.

Nova Scotia. Blue or yellowish-gray color, and of all grits, from the finest and hardest to the coarsest and softest; the large ones for grinding sad-irons and hinges, springs and edge-tools; the medium and small sizes for machine shops and for sharpening edge-tools generally.

Bay Chaleur, N. B. Of a uniform blue color, and soft, sharp grit; for manufacturing table cutlery, and is admirably adapted

for machinists' tools, and for sharpening edge-tools generally, when a fine edge is required.

OHIO.

Berea. White color, fine and sharp grit; for sharpening edge-tools generally.

Amherst (Black river). Brownish-white color, soft, loose grit; for edge-tools, and the very soft ones for saws.

Independence. Grayish-white color, and coarse sharp grit; for grinding springs and files, and for dry grinding of castings.

Massillon. Yellowish-white color, coarse, sharp grit; for edge-tools, springs, files, and nail-cutters' face stones, and for dry grinding of castings.

Huron (Michigan). Of a uniform blue color, and fine, sharp grit; good for sharpening tools when a very fine edge is required.

Glass-cutters' grindstones, of Newcastle, Warrington, Craigleith, and Yorkshire grits; for checkering, mitering, fluting, and for punty-stones.

Cutlers' grindstones, of Newcastle, Nova Scotia, and Wickersly grits.

Shank stones, for table cutlery.

Curriers' rubstones, of Newcastle, Nova Scotia, and Ohio grits, for first and second stones; and Scotch Water of Ayr, Welsh, and Hindostan, for clearing stones.

Scythe, oil, and whet stones, Ouachita, Arkansas, Orange, and Scotch Water of Ayr stones and hones, shoemakers' rubbers, and scythe-stones.

DOUBLE HUNG GRINDSTONES.

There is a mode of hanging grindstones which is very popular in England, although not used to any extent in this country. Its advantages over the old method consist in having two grindstones, a coarse and fine one if desired, hung in one box, each stone having an independent motion, both lengthwise and lateral, by means of which they can be brought into contact when running at unequal rates of speed, and thereby keeping each other perfectly true, the lateral motion preventing the stones from cutting into rings. Grindstones hung in this man-

ner, must, of necessity, remain perfectly round and straight on the face, thereby allowing the tool to be ground with the greatest precision, an absolute necessity in the present perfection of machinery. A tool of this kind in constant use soon overcomes its first cost by the time saved and the perfect work done, and it being made in the most durable manner, the machinery will outlast several sets of grindstones.

MISCELLANEOUS ITEMS.

Power grindstones are from three to six feet in diameter, hung on round wrought-iron shafts, from one and one half to four inches thick, with self-adjusting plates and screws, and running on heavy clamp boxes, bolted through the sides of the frame, which are of yellow pine or oak, with heavy oak legs securely bolted to the sides. The stone is driven by a belt and pulley.

Hand and treadle grindstones are made of all sizes and grits, from twelve to thirty-six inches in diameter, and hung on strong wood frames, with self-adjusting cranks, and running on friction rollers or sockets. They are furnished with water-pot, handle, and treadle, and are driven by hand, or can be turned with the foot without assistance. They are intended for farmers and mechanics generally, and cost less than to buy the stones and fixtures separately.

High-leg grindstones are from twelve to twenty-four inches in diameter, and of fine grit. They can be used when standing erect, and being driven by the foot with a treadle, they are a great convenience to amateurs, and are a good stone for family use.

The kitchen grindstone is one of the most desirable things to have in a family, to sharpen knives for the table. The fixtures heretofore used for the purpose have been so badly contrived as to be almost useless. This article obviates these objections, being durable, cheap, easily worked, and not liable to get out of order. It is screwed to the kitchen table, and by one turn of the handle turns three and a half times, which puts on a keen edge, without any danger of the knife cutting the hand. When the stone is worn out, a new one can be readily fitted for the spindle, so as to run true without trouble. The stones vary from eight to twelve inches in diameter.

PREVENTABLE LOSSES.

BY PROF. I. P. ROBERTS, OF CORNELL UNIVERSITY, IN THE AGRICULTURAL REVIEW.

A simoom sweeping over the country at the rate of twenty miles per hour, sucking up what little moisture remains in the sun-parched earth; the cattle on the distant hills lowing by the empty water-trough, or trying to get a little sustenance from a few dry weeds; the horse and driver reeking with sweat and panting for breath as they make their weary way amidst the dust and clods of the prospective wheat-field; the sad-looking trees reluctantly parting with their brown and prematurely ripened leaves; the verdureless corn-blades whipping and lashing each other as though angry at dying before their mission has been accomplished; the miller in the shadow of the mill, sitting listlessly, driving away the hungry flies as his neighbor's thirsty, far-driven cattle drink his mill-pond dry—these and like scenes may be witnessed in many localities of the United States, not only this year, but almost any year. The corn designed for ensilage, eight feet high, and luxuriant, August 1, hesitates to put forth tassels, throws off or rolls up its leaves, and comes to a stand-still; the farmer drops everything, and with the thermometer at 100° F. hastens to secure it. As we wipe the sweat and dust away, and seek the grateful shade of the house, where the temperature is not much above 90°, two questions present themselves:

First.—Is the climate changing, or subject to greater variations than formerly? If so, what are the causes, and are there any remedies?

If we form our judgment from early records, and the testimony of octogenarians, we must conclude that the climate is changing, and subject to greater extremes than formerly. The

chief cause of this is not hard to discover, for look which way we may, we see the steep slopes and hillsides denuded of their forests, parched by the sun, furrowed and seamed by the rains, and robbed of their fertility by man.

The autumnal and spring rains will soon tear down their inclines, carrying destruction in their pathway instead of fertility and gladness, and the recurring summer will find the farmer sweltering in the dry wind as he strives to cultivate the arid fields. Is there no remedy? I believe there is, and that many thoughtful men fully understand it, but that the difficulty lies in its application.

Reclothe the hills and waste places with forests: their nakedness should never have been revealed. But how and by whom shall this be accomplished? Many see and deprecate the present condition of things, but few, if any, have pointed out a feasible and systematic remedy.

The state governments should compel the railway companies to so construct their locomotives that they cannot set fire to the forests adjoining their lines of road; or, if locomotives cannot be thus constructed, a sufficient number of track-walkers should be employed to extinguish incipient fires. There are large tracts of hill lands, that have been cut off, that would rapidly produce a second growth of valuable timber if all domestic animals were kept off of the land and fires kept out.

These lands might be exempted from all taxation so long as these two conditions were complied with. All ungrazed and planted timber lands should also be exempted, and all planted timber of five acres and upward should receive a premium, according to the value of the improvement, as a rebate of the taxes on cultivated lands. All planted trees along the public roads set off the line, but near its borders, and those in good condition set within given distances on the lines between farms or fields, or along private lanes, should be taken account of as to number, kind, age, and value, as carefully as horses or cattle, and, to the extent of their general value and usefulness, they should form a rebate of taxes assessed on other property.

So much, it appears, it is feasible for the states to accomplish.

I would not interdict the cutting of timber, but rather, in some instances, I would encourage it. Like other products of

the earth, it is for the comfort and welfare of man, but its wanton destruction or non-replacement borders upon a crime.

We cut the ripened harvest with joy, but with equal pleasure we cast in again the seed. The Lord has made some land so steep and stony that even the nimble Yankee with a side-hill plow cannot cultivate it; and I am glad of it. I sometimes think that it would have been better for the world if the man who invented the side-hill plow had died in his cradle of cholera infantum.

I often see ten or a dozen scrubby trees in a nice arable field of as many acres. They are simply weeds—plants out of place—and should be eradicated root and branch, and ten should be set, in an appropriate place, for every one destroyed. An acre of land planted with appropriate varieties, and properly cared for, may be made ten times as profitable in the long run as the same area of average natural timber.

The national government still has it in its power to preserve and even improve much of our timber land, and at the same time to derive some revenue from the sales of timber. But will it do it? Or will it let the thoughtlessness and the grasping propensity of our people, lacking a little knowledge and direction, curse the earth they were set to dress and keep, till a portion, at least, literally burns up before the appointed time?

Second.—What proportion of the losses and failures in agriculture are justly attributable to ignorance and carelessness, and what to climatic and other causes over which we have almost no control? How may these losses be avoided?

It is estimated that fifty per cent. of the losses at sea are preventable, while the other half occur through causes which no human forethought or care could obviate. The preventable causes of loss in agriculture are equal to, if not greater, than those at sea. Each day of the last half of August and the first of September rolls up losses by the million in the single domain of agriculture. Notwithstanding this, all the provident and industrious will have something to eat; but when we consider that this loss will affect every household in at least five great nations of the globe, and some most seriously, it becomes not simply a subject of agricultural importance, but one of great national interest as well. The honest day-laborer, whose weekly wages

in ordinary times scarcely suffice to feed and warm his numerous family, will find the coming winter a sad one, as he pays fifty per cent. advance on flour, one hundred on corn, and two hundred on potatoes.

Will it be strange, as the market is "bulled" and "beared" for the sole benefit of the speculator, if he lends a listening ear to Communistic doctrine? If fifty per cent. of this year's losses could have been prevented, how different would be the outlook to the toiling masses who constitute so large a proportion of the people.

The question recurs,—What portion of these failures could have been prevented?

I see harvested on one farm a moderate crop of corn and potatoes; just across the fence the yield is only about half as much, and just beyond it is a total failure. The land has every appearance of being equally fertile naturally. All have suffered from the drought, but not all alike. Here are certainly losses due to thoughtlessness and want of knowledge. It is supposable that each of these parties did nearly as well as their knowledge, training, and energy permitted; yet the results are widely different, caused by the different *degree* of these elements possessed by each. If this be so, then to avoid the losses of the less successful farmer, his knowledge and land must approximate towards those of the more successful one.

I have cited what I consider preventable losses of only two men, but there are thousands of just such men, and tens of thousands of just such cases, in every state. Who is to energize and instruct them? Who is to train and educate the 12,000,000 youth that now reside on the farm, so that such losses may not occur in the future? Who is to keep our honored fathers abreast of the times—who were born in the beginning of the century, with limited opportunities for acquiring knowledge, and are hardly able to keep pace in their growth unassisted—with the improvements wrought by machinery, steam, and chemistry?

Twenty millions of men, women, and children on the farm, all to a greater or less degree desiring to be taught how to avoid the preventable losses and failures! Who is to do it? How is it to be done?

As I have intimated, the national government should do its part by organizing a national department of forestry, with able men to gather and disseminate facts; to control, protect, and improve such portions of forests as are yet under national control in such a manner as would conduce to the greatest good of the greatest number. I have already spoken of a few things that it is feasible for the states to accomplish; the reader will doubtless think of many more. But should nation and state both do their duty, the work will hardly have been begun.

To supplement the work of government, we have for every million of farm population about one professor of agriculture, one leading agricultural journal, and, possibly, one prominent farmer who is directing his operations largely for the welfare of the public. There are many other educational forces at work in this great field; but, when we count them all, how meagre the teachers in proportion to those to be taught! If, on an average, it takes the united effort of about two grown persons to educate, train, and provide for three children, what headway can this little handful of teachers make with their twenty million of pupils?

The preventable losses of a single day are often more than the total yearly expenditure for their avoidance, and the total income of all the agricultural colleges less than the losses of an hour.

When I see the losses incurred for the want of knowledge, or the judicious application of it, not only on the subject of forestry, but of drainage, tillage, insects, animals, and a thousand others, I feel that one ought never to criticise the smallest effort or the least knowledge in these directions.

There is not only room and work for all of us, but for ten times as many.

I trust that the day may not be far hence when there will be as many societies for the promotion of agriculture as there are school-houses in the land, and as many teachers of at least the elements of agriculture as there are school-districts.

Knowledge, work, and perseverance can relieve us of many losses and failures, but they *must* come in the order named, for the greatest of these is *knowledge*.

PEAR-TREE DISEASE.

In various sections of the state, during this spring of 1883, a disease has fallen on the pear-tree, and in some instances has affected the apple-tree. It seems to begin at the blossom or fruit near the ends of the twigs, at first perceived by the withering of blossom and leaf. The stem or twigs present the appearance of having been scorched by sun or fire, and very soon become dry and hard. Following the twigs, it extends to limbs, and sometimes the entire branch to the extent of several feet loses its sap and dries up.

The disease is evidently new, not like the well known pear blight, but something more rapid in its work and more fatal. Samples were put under a small magnifying power which disclosed minute insects, and in another instance distinct fungus. Neither of these was probably the cause, but likely the consequent of the disease. No one with whom we have conferred has a familiarity with the nature of this enemy of pear growth, though many fruit-growers have examined the effects. The secretary of the board sent specimens to P. M. Augur, the pomologist of the Connecticut board, who made the following reply, after having examined them:

MIDDLEFIELD, CONN., July 16, 1883.

J. O. ADAMS, *Secretary:*

Dear Sir: Thanks for the specimens of fungus sent—very interesting, but I conclude very destructive to your fruits. For scientific description, please send fresh cut specimens, packed in live moss, dampened slightly, to Prof. Farlow, Bussey Institute, Jamaica Plain, near Boston, who is authority in such matters.

Now a few words in regard to what we can do about it. In this as in other evils, an ounce of prevention is better than a pound of

cure. These evils often make a general visitation, and we are, at the time, powerless to stay them. I think, however, we should go back to general principles, and, first, do all possible to promote the general health of the tree or orchard. It is perhaps oftener the case with orchards than with most vegetable crops, that there is in the soil a deficiency of some important element required for perfect normal growth and fruitage. Heavy growth and fruitage may have overdrawn some needed material. To illustrate: A Connecticut farmer had a barren orchard. He said "the climate had changed; could n't raise apples now." He had occasion to make a mortar-bed under one of his trees. The bed leaked lime-water badly, but that tree came at once into full bearing. A general application of quicklime slacked on his orchard had a similar good effect. So some important element may often be wanting, unsuspected. We have made free use of muriate of potash, unleached ashes, finely ground bone and oyster shell lime—some four hundred bushels of the latter this season.

In a malarial district I would advise all residents to closely observe the laws of hygiene,—to live well, but avoid all excess. So in the orchard: to best escape evil fungi, feed, cultivate, and prune well, but avoid excessive growth and overbearing. Lime is nearest a specific against fungi which is practicable than anything that I know of, but by no means certain in all cases. Twenty to forty bushels per acre according to fertility of soil. Most on rich land.

In haste, yours, etc.,

P. M. AUGUR.

On Mr. Augur's suggestion, samples were sent to Prof. Farlow, who at once acknowledged their receipt, and soon after gave the result of the examination. He says,—

CAMBRIDGE, MASS., July 25, 1883.

HON. J. O. ADAMS:

Dear Sir: The box, containing diseased pear twigs, was received yesterday. The leaves and branches contained specimens of several species of fungi of which the two most prominent are *sphæropais malarum* and *cladosporium stenasporum*. The former is on the branches, the latter on the leaves. The

important question is, whether the disease is caused by the fungi named, or whether they are merely growing on the already diseased leaves and branches. Of course a much longer examination is necessary before one could speak with certainty; but as it is, I must say that I do not think that the trouble is to be attributed to the species of fungi which I have mentioned, but rather that they attack the different organs after they are already diseased. The real cause of the trouble I cannot discover from an examination of the specimens sent.

From your letter I gather two facts,—first, that the disease has not been before noticed in your region; second, that it attacks both apples and pears. Have you not already had in New Hampshire for some years what is commonly known in Massachusetts and many other states as pear-blight, in which the leaves and branches blacken and the tree finally dies? Our pear-blight looks a good deal like what you send; but it does not occur on apples, as you state in your letter. The cause of our pear-blight has been sought for many years; but so far no definite fungus can be assigned as the cause. Some persons consider that the blight is caused by bacteria.

If I am correct in assuming that you feel sure that the trouble has not before appeared in New Hampshire, may it not be that the present trouble is in some way connected with the drought and heat of last summer? I would suggest that an examination be made of the roots, especially the smaller ones, to see whether anything could be found there.

Yours respectfully,

W. G. FARLOW.

We are not aware that any examination was made of roots. It was suggested to several parties, but no report of any investigation came to the secretary. It did not continue many days, but during its presence it was very destructive. It may reappear the next season, when it will be more fully investigated.

FERTILIZING AND PREPARING SOIL.

BY EDMUND HERSEY, OF HINGHAM, MASS.

[At one of the meetings of the board, the author of the following, being present, was called up, and made an interesting and valuable impromptu talk on the growth of plants, and the proper method of fertilizing and preparing the soil for their successful culture. Only a brief abstract was made of his remarks at the time. Finding an essay on the same theme, and embracing the same thought, in the "Transactions of the Massachusetts Horticultural Society," we copy from that reservoir of good things in the line of fruits and flowers.—SEC'Y.]

The subject covers so wide a field for thought, that the time allowed is not sufficient to give even an outline of the principal points. I therefore confine myself to two points,—first, the power of plants to gather up their special food; second, the condition of soil to grow crops to the best advantage.

Nature, when left to herself, has ways of her own for fertilizing and preparing the soil for the moderate growth of native plants, but when man demands of her an excessive growth of either native or foreign plants, and removes from the soil both the stalk and the seed, she refuses to comply with his demands unless he makes especial efforts to assist her, by the application of fertilizers and the pulverizing of the soil, to supply the increased demand thus made upon her.

Whenever we make an attempt to produce more than a natural growth of vegetation on any soil, if we would work to the best advantage we need to know something of plant growth,—a subject which we scarcely enter upon before we find ourselves surrounded by the most minute complications, shrouded in mystery, yet always working out the same results.

The rose, the pink, and the strawberry will grow side by side, the roots mingling together in the same soil, and the branches and leaves intertwining in, and surrounded by, the same air; yet the rose-bush gathers up and manufactures the particular substance necessary to produce the wood, the leaf, and the flower of the rose, while the pink, from the same sources, gathers up materials necessary to produce the stalk, the leaf, and the flower of the pink; and the strawberry gathers from the same soil and air the material that forms, not only the stalk, the leaf, and the flower, but also the luscious fruit; and each from the same sources gathers up the delightful odors so peculiar to the flower of each plant. Compare the fruit of the strawberry with that of the rose, or with the seed of the pink, and how unlike they are, yet the roots and leaves feed upon the same materials.

The question arises, Do the leaves and roots of plants have the power of selection, and of taking in precisely what is required to produce all of the peculiarities of each plant? Evidently they do not, except to a limited degree. If they did, would they not refuse to take up poisonous substances, which they sometimes do in such quantities as to destroy the life of the plant? Must we not come to the conclusion that each plant is provided with a laboratory wherein is manufactured the particular substance required to produce all of the peculiarities of the plant and the fruit? in fact, is there not much evidence to prove that each minute cell, of which plants are composed, is complete in itself, and capable of manufacturing out of the substances drawn up through the roots and absorbed by the leaves, a material which will produce another cell precisely like it, and also a material possessing all the peculiarities of the fruit of the plant, which the stalk and leaf represent? We get some evidence of this if we take a seedling apple-tree, with two branches, grafting one with a scion of the Sweet Bough, and the other with a scion of the Baldwin apple. As the material for each branch of the tree is drawn up by the same roots, there can be no doubt that the material which enters the wood of the scion of the sweet apple is precisely the same as that which enters the wood of the scion of the sour apple. Yet, when this is acted upon by the air drawn in by the leaves, in the cells of the wood of the sweet apple, the result is the formation of the material necessary to pro-

duce the form, color, and flavor, as well as the keeping qualities, of the Sweet Bough; while that which enters the cells of the wood of the sour apple, produces that substance necessary to produce the form, color, flavor, and keeping qualities of the Baldwin apple. To discover the difference in the structure of the cells of these two varieties of apples requires higher perceptive powers than have as yet been given to man. We only know the results; in contemplating them we are lost in wonder, and filled with admiration at the perfectness of structure and the positiveness of action of these minute germs of vegetable life.

The more closely we examine the vegetable world the more perfect we find it, and the higher is our admiration and the stronger our love for that Supreme Intelligence which governs the universe, even to the smallest germs of animal and vegetable life.

I have thus apparently diverged somewhat from my subject, but it has been done to call your attention to the power of plants to gather up the fertilizers applied to the soil and convert them into substances that represent the peculiarities of each plant. The chemist tells us that the three principal substances which we need to apply to the soil to assist the growth of plants are phosphate, potash, and nitrogen. Chemistry also teaches us that plants contain large quantities of carbon; but we are taught that carbon, in the form of carbonic acid, is floating in the air in sufficient quantities to supply the wants of growing plants. This may be true, and probably is, where only a natural growth is required, but where an excessive growth is required there appears to be good evidence to prove that a larger quantity is beneficial. The atmosphere contains only about six parts of carbonic acid to each ten thousand parts, while the air in good garden soil contains more than four hundred parts, and a newly manured field, during wet weather, more than one thousand parts to each ten thousand. As vegetation on well manured land grows very rapidly after a shower, it is evident that the large quantity of carbonic acid which must necessarily be in the soil does no serious injury, but some good. There may be, and probably is, a point beyond which it is not safe to furnish carbonic acid for plant growth, but it is evidently not often reached in the cultivation of plants in the open air. The presence of large quantities of carbonic acid in the soil is believed to be beneficial, not so much by

direct action on the growing plants as by its action on the soil, dissolving valuable mineral elements, and rendering them available for plant food.

In fertilizing the soil we should ever keep in view the fact that everything which enters into plants must first be reduced to atoms; and it is also well to keep in mind the fact that nature has wonderful power to assist man in this reduction. If we apply coarse materials to the soil, the heat, the air, and the moisture commence at once the work of decomposition, the rapidity of which depends on the character of the materials applied and the manner of its application.

As our principal object in the preparation of the soil is to encourage rapid plant growth, we should endeavor to make ourselves familiar with those conditions necessary to accomplish this purpose. It being already understood that all fertilizing materials, before becoming plant food, must first be reduced to atoms, and be of a character to mingle with both water and air, it is evident that in the application of fertilizers we should make an effort to place them where they will change into atoms fast enough to supply the wants of the growing plants, and it is also evident that the soil should be changed into that condition best adapted for the rapid decomposition of coarse materials applied. If we apply stable manure, it should be placed where it will receive the heat of the sun, the oxygen of the air, and the moisture of the earth; all of which act on the materials of which the manure is composed, separating the mineral from the gaseous portions, and reducing them to minute particles. Good cultivators have learned that rapid growth is best secured by thoroughly mixing the manure with well pulverized soil, keeping it within a few inches of the surface: this is because the light, pulverized soil readily admits the heat, air, and water.

The fact should not be overlooked, that, for rapid plant growth, the soil should be made light by considerable quantities of partially decayed vegetation. A soil with all of the coarse particles removed by sifting through a fine sieve, would not be so well adapted to the rapid growth of plants, as a soil lightened up with partially decayed vegetation, for several reasons. First, because, being more compact, the air is in a great measure shut out; second, the particles of earth being so fine, there is nothing

to keep it from becoming soggy with the first rain, and becoming firm and hard as soon as it dries; third, there being no vegetation to decompose, there can be no rapid manufacture of nitric acid, or nitrous acid and ammonia, and, in fact, no carbonic acid, all of which are necessary for plant growth, and also necessary to produce a chemical action on the soil. Whenever we apply highly concentrated fertilizers to the soil, we should always do it in connection with coarse manures, or apply it to soils already rich in partially decayed vegetation.

It should always be our aim to keep the soil so light and loose near the surface, that the air and moisture will have a free circulation through several inches in depth, for these are the true elements which join hands as messengers, and unite with the atoms of phosphate, potash, lime, silica, nitrogenous compounds, and other materials, and when united carry them to the roots of the growing plants.

In preparing the soil for growing plants, there is still another point that should not be lost sight of, which is, that if we would secure the most rapid growth, we must not only have the soil so prepared that the air and moisture will readily circulate through all portions of it to the depth of several inches, but we must also have the soil filled, during the period of plant growth, with all the elements of plant-food in that particular form necessary to readily unite with both the air and water; yet if we would use economy in our operations, we must avoid applying more fertilizers in a soluble form than the plants can consume. Especially is this true of nitrogenous compounds.

He who applies a hundred cords of manure to the acre, manufactures nitrogenous and carbonaceous substances more rapidly than the most vigorous growing crops can consume them. While possibly the crop might be larger than if only twenty cords had been applied, it would be grown at a much less profit, except under very extraordinary circumstances; for plants, like animals, can consume only a limited amount of food; and plants, like animals, to keep them healthy, must have food containing the different elements in the right proportions. For example, if we should apply large quantities of nitrates to the soil, with no phosphates or alkalies, our plants would refuse to grow with any vigor. So with any other single element.

To work judiciously we must work intelligently, and apply to each crop the proper proportion of each element. This is a work not easily accomplished, for, though the chemist can tell us what each plant is composed of, he cannot so readily tell us from what particular source each element is derived; and as few of the materials applied as fertilizers have passed into the form of available plant food, we are compelled to judge how rapidly they will change, or we cannot tell what quantities it is necessary to apply to furnish each particular element as fast as needed by the crop.

In no department of agriculture is light more needed than in that which relates to the application of manures. It is very easy to make an expensive mistake, by applying more manure than enough to supply all the wants of the growing crop, and by applying it in such condition, or in such manner, that it will not have become plant food until long after wanted by the growing crop. Thus the plants suffer for the want of food while surrounded with more than sufficient, but in a state that cannot be taken up. When coarse manure is covered up eight or ten inches in depth, and permitted to remain undisturbed, it must not be expected that it will be converted into plant food as quickly as if applied within a few inches of the surface, where it will be disturbed every time the crop is cultivated. While it is important that a portion of the fertilizers should be applied in a condition and in a manner to furnish plenty of food to the young growing plant, it is also important that a considerable portion should be applied in a condition and in a manner to furnish food to the maturing plant and the ripening seed.

In high culture, care is taken to keep the land filled with fertilizers in different stages of decomposition, that the plants may, in all stages of growth, have plenty of food; but in ordinary field culture we do not usually do this, therefore we often fail to get a good crop,—not because manure enough has not been applied, but because it has not become plant food at just the time needed by the growing crop.

He who would be a successful cultivator should be a close observer of nature, and should strive to become as familiar with the wants of growing plants as he is with the wants of farm animals; for to tend and feed growing crops with the greatest

economy requires quite as much intelligence as to care for and feed cattle successfully.

The farmer who should gather up winter fodder for his cattle, and then leave it in the open air to waste its nutritive qualities, would be considered as adopting a very wasteful practice; but the same farmer might compost all of his manure in the open air, and leave it six months, without exciting a single remark; yet the manure, in the process of decomposition, will lose a considerable portion of its plant food, and will also have its power to create important chemical changes in the soil greatly reduced. It is believed by some, that when vegetable substances are decomposed in the soil, nitrogen is manufactured, by a process not yet understood, in quantities so large that a portion of it must be drawn from the air.

It is becoming more and more evident, that, in field culture, barn manure should be applied in a fresh state, and so mingled with the soil as to encourage rapid decomposition, and thus create a mechanical as well as chemical action on the soil, which is highly beneficial to the growing crop, and which would be lost if decomposition was permitted to take place in the compost heap.

In conclusion, I would call your attention to the fact that the over-application and misapplication of phosphate and potash does not result in that loss which is caused by the over-application and misapplication of materials containing nitrogen and carbon, because, though the soil is filled with molecules composed of mineral substances, water, and air, to an extent far beyond the capacity of plants to absorb, when they reach the surface of the soil the water evaporates and the air mingles with its native element, thus separating from, and leaving in the soil unconsumed, the mineral elements; but when the soil is overcharged with molecules made up of air, water, and nitrous acid, in combination with ammonia, or carbonate of ammonia, the moment they come to the air they mingle with it, and are thus lost, so far as relates to any future advantage to the soil.

From this the natural conclusion is, that, in fertilizing the soil for growing crops, we may apply with a liberal hand both phosphate and potash without fear of loss, except by leaching; but that when we apply those elements of fertility which change to

a gaseous form, it is not, as a rule, economy to apply them in quantities much larger than the growing crops can consume.

DISCUSSION.

Following the essay of Mr. Hersey, there was an intelligent discussion given in the Horticultural Report, which indicated a dissent from certain positions taken by the speaker. It is not generally understood that phosphoric acid or potash leach through even a thin soil, but nitrogen in some forms will readily pass into the earth beyond the reach of ordinary roots, unless, as Dr. Miles tells us, the soil is covered with growing plants. Col. Wilson, it will be seen, says no form of nitrogen is plant food. We do not suppose he means that nitric acid or ammonia are only solvents. It is very probable that we waste money in buying nitrogen, as Prof. Atwater says. This was proved at our college farm by Mr. Sanborn, before it was enunciated by Prof. Atwater. It was also suggested, at least, by a studious farmer of Merrimack county, at about the same time.

John B. Moore said that away from cities it is becoming a serious question how we are to grow crops, and restore and keep up the fertility of soils which have been depleted by over-production. The essayist is right in the belief that chemical fertilizers should be applied in connection with coarse manures. Market gardeners can see no benefit from chemical fertilizers; but how should they, when they apply along with them as much stable manure as the crop needs? The speaker had seen very large crops of corn grown year after year with chemical fertilizers. But the question comes up, How are we to get them? For, at present, it is evident that they cost more than farmers can afford to pay for them, though they are better than formerly. The nitrogen which they contain is from various sources. They are all valuable, but it is useless to apply them to plants which are not in vigorous growth. He had seen a dressing of nitrate of soda applied to grass in autumn, when it is utterly useless. It disappeared either by leaching or evaporation, but if applied in spring it would have caused a heavy growth. The lysimeter does not show any loss of potash and bone by leaching, but it does show a loss of nitric acid in the winter, but not in the grow-

ing season. He had found by experience that it is unnecessary to pay any attention to providing a supply of nitrogen, but is of the opinion that, with the ordinary methods of manuring, Nature will provide a sufficient quantity. He believes that it is manufactured in the soil by the condensation of the nitrogen of the atmosphere, or enough is supplied by the decomposition of stable manure. Constant cultivation and stirring of the soil cause it to absorb nitrogen from the air. Of two pieces of corn or cabbages, one of which is frequently stirred and the other is not, the former will be much better than the latter; and this superiority is not due to mechanical action alone. But it is necessary to provide potash and phosphoric acid. No chemist can tell in what form any substance will be fifteen minutes after it is put into the soil.

Col. Henry W. Wilson said that in preparing soil for the growth of plants it is not generally stirred more than from six to ten inches in depth, but he thought the deeper it is stirred, inside of four feet, the better. A box of earth four feet in depth will hold all the moisture necessary to support vegetation. No plant can be induced to send its roots below the water-table,—that is, the level at which water stands in the soil. If this is too high it must be lowered by draining. He could judge by the character of the grasses on a given soil whether it needed draining. Thorough pulverization, in connection with perfect drainage, is the most important operation on the soil. Air is the great disintegrator, and oxygen is its great agent in that work. No form of nitrogen is plant food, but only a solvent. The atmosphere is the great source of nitrogen; all the upper parts are filled with nitrogen clouds, which are absorbed and brought down by the rain. Carbon in the soil is one of the constituents of butter and sugar, and by roasting the soil, the carbon is supplied in a form to be taken up. The essayist spoke of plants' absorbing atoms, but no particle of undissolved matter can enter a plant; their capillary organs are so minute that food can enter only in solution. They cannot assimilate particles. Potash is not easily evaporated, and so its virtue remains in the soil for the ensuing year, but ammonia applied in the autumn is lost. All fertilizers should be applied in a neutral form: lime is harmful to land, and so is sulphuric acid, but when applied in combi-

nation, as sulphate of lime, the water and air decompose it just fast enough, and all fertilizers should be in such neutral form that the forces of nature will dissolve them. If we attempt to make superphosphate of lime by adding sulphuric acid to bone we shall fail, but if we put water first, and then add the sulphuric acid, we shall succeed.

Mr. Wetherell said that he has a good farm, and where he ploughed bound-out grass-land six inches deep, and harrowed the same way, and then applied the Stockbridge formula for corn, and harrowed again crosswise and planted corn, he got one of the best crops he had ever had. An Ohio farmer said that he had never seen a better crop. There were eighty bushels to the acre, and the crop was not so great in seed as in growth. The late Moses Stebbins, of South Deerfield, bought an old, worn-out farm, in the Connecticut valley, with alluvial, where the surface was exhausted, and ploughed deep and turned up fresh soil, to the increase of his crops. Mr. Stebbins recommended John Green, at Hadley, to plough deep, because of his own success, but Mr. Green's soil was light, with a gravelly subsoil and little humus, and when the plough was put down deep in that soil, the difference could be seen in the following crop: the humus was all turned under the gravel. Ploughing must be adapted to the soil.

Nitrogen is commercially the most valuable fertilizer; some forms are highly active, and others slow in their action. Ammonia and nitric acid are the most active forms. Seventeen parts of ammonia contain fourteen parts of nitrogen. The speaker thought the amount of nitrogen taken from the air by plants very small: clover, however, is an exception. Corn and wheat give no perceptible proof of having absorbed ammonia from the air. Clover is deep-rooted, and brings up food from the subsoil, and is therefore one of the best plants for turning under as a green manure. When it has been tried side by side with stable manure it has brought better corn. This is an important and fertile subject, and it is not exhausted. We want to retain the fertility of our farms, and to save the cost of commercial fertilizers. The margin of profit in their use is too small. Prof. Johnson says it is a question whether farmers can afford to pay the prices of commercial fertilizers. Prof. Atwater says farmers use too much nitrogen.

Col. Wilson asked, By what rule are we obliged to prepare soil with a plough? There are cases where the soil must be stirred four feet in depth to gain the best results, as in making lawns. The question is, What depth of soil will hold so much moisture that the rain which falls on it will be sufficient for the wants of the crop? Strawberries and grass need a great deal of water; grapes need very little. In California, with a drought that endures all summer, vines in the vineyard will ripen thirty pounds of grapes to the vine, whereas in our moist climate many a man kills his vines with kindness by too constant watering. The preparation of the soil is the first element, and must be adapted to the crops.

There are chemical reactions in the soil whereby nitrogen is released. The great source of nitrogen is the atmosphere, which contains eight parts of nitrogen to one of oxygen, and in every expiration of animals all the oxygen is absorbed and almost all the nitrogen given off. Carbon has a greater affinity for potash than nitrogen in the form of ammonia or nitrates. If you put water into cologne it becomes turbid: alcohol and water have greater affinity for each other than alcohol and essential oils, and when potash in a caustic form is mingled with composts containing ammonia, the organic carbon in the compost combines with the potash, and the ammonia is at once released and lost.

Josiah W. Talbot said, in regard to the statement of the essayist that substances must be reduced to atoms before they can be taken up by plants, that the expression is not a good one. They must be either dissolved in water or be in the form of gas, and it makes very little difference which. It is admitted that all plants are half or more carbon; and the question comes up, How is carbonic acid formed? The oxygen in the atmosphere takes hold of the carbon in the plant. When we stir the ground we admit air, and it comes in contact with vegetable matter and changes it into carbonic acid gas, which is plant food. Many articles are dissolved in the soil, and so taken up. Plants will send their roots down to where they can get moisture: the roots of elms have been found twenty-five feet down. Strawberries will go down to where they can get moisture, and in preparing ground we must go so deep that the sun will not dry the roots. In reclaiming the marshes at Marshfield the ground is sometimes

cultivated only by harrowing when it is liable to suffer from drought. The peaty formation should be cultivated deeper.

Mr. Hersey said that by an atom he meant the smallest division of matter possible, though he might, perhaps, have said in solution, but he thought the paper showed fairly that plant food should be in solution. He had been experimenting for more than thirty years in regard to the depth to which it is best to plough, and had come to the conclusion that every man must learn his own soil, and stir it as its condition requires. His own soil does not give as good results when stirred deep as when stirred shallow. He had land trenched two feet and a half in depth many years ago, which was injured thereby, and still shows the injury. We can only learn general principles here, and must go home and apply them according to the condition of our soils.

THE HESSIAN FLY.

COMPILED BY THE SECRETARY.

Though New Hampshire is not a wheat-growing state, it has many localities where spring wheat has been grown successfully, and formerly winter wheat was cultivated to some extent. There are several enemies of this crop, one said to have been brought into our country by the Hessian soldiers, employed to aid the British forces during the Revolution.

The pages which follow are the direct work of a commission of entomologists, appointed to investigate the pest and present a remedy. The opinions of others have been given, sometimes without credit, but always with a view to give a clear understanding of the insect.

INTRODUCTION.

The Hessian fly—scientifically styled the *Cecidomyia destructor*—is at times one of the most destructive of our noxious insects. It attacks wheat, and has in many localities caused farmers to abandon the culture of this cereal. While the fly has been well known and destructive for about a century, the vast extension within a decade of years of the wheat-growing area of the West, and the corresponding prevalence of the fly in the North-Western states, together with its wide-spread destructiveness, have given fresh interest and importance to this pest. Moreover, the cultivation of wheat in the New England states, where about twenty years ago it was abandoned on account of the ravages of this fly and the wheat midge, has been resumed in part, so that the dissemination over the wheat area of the United States of the known facts in regard to its habits and modes of doing injury seems necessary.

Though the habits of the Hessian fly are tolerably well known, much additional knowledge is desirable regarding its distribution, its breeding habits, and its parasites; while in order to properly apply the best preventive remedies, to stamp out the pest as it appears in new wheat sections, we need the results of a larger number of experiments as to the effects of early and late sowing, what varieties of wheat to sow, and as to the value of manures and artificial fertilizers in promoting the rapid and healthy growth of the young wheat, by which it may outgrow the weakening effects of the worm and ripen its grain.

LOSSES OCCASIONED BY THE PEST.

This fly first became a serious pest in the country in the year 1779, although it probably began its work of destruction on Staten Island and Long Island in 1776. According to Fitch, 1779 was probably the date when its ravages actually began. The crops of wheat were severely injured or wholly destroyed by it in King and Richmond counties during several of the following years, and each succeeding generation regularly enlarged the sphere of its devastations in every direction.

In 1781 the fly almost totally destroyed the wheat crop in eastern Long Island, and in 1786 the crops were either totally or partially destroyed in New Jersey in and about Prospect, an area situated forty miles south-west of Staten Island. In 1786 and 1787 the ravages of this pest attracted much attention in New York and Pennsylvania, the wheat crop on eastern Long Island having been "cut off almost universally." About Trenton, N. J., in 1788, the wheat crop was in many cases a total failure. As wheat in large quantities was at this period exported to Great Britain, "accounts of the appalling havoc that this insect was making excited the attention of the government there, and aroused their fears lest so dreadful a scourge should be introduced into that country by means of the American grain." As a result, the exportation of grain from America was prohibited, until the English government was assured that the fly with eggs could not be introduced in the grain. As long since as 1800, Dr. S. L. Mitchell, of New York, affirmed that "the insect is more formidable to us than would be an army of twenty thousand Hessians."

At what year the Hessian fly first occurred in the New England states is uncertain. So far as we can ascertain, it was first noticed at New Haven, Conn., in 1833, by Mr. Herrick, a careful entomologist, but without doubt it was introduced from New York early in the century. Dr. Dwight, president of Yale college, spoke of it as being known in Connecticut in 1804.

In Lower Canada, it was, according to Hind, between 1805 and 1816, "prevalent and destructive in some parts," but in 1830–'36 it disappeared.

In the Eastern states, it has been generally harmless for thirty years, having been starved out by refraining from wheat cultivation. Now we are beginning to grow wheat, and shall probably experience a return of the insect.

The losses from the Hessian fly are greatest in the grain-raising areas of the Middle and North-Western states, and adjoining regions of Canada. No statistics as to the losses have ever been collected, either by the state or national governments, but they have been sufficient to occasion much consternation and alarm at certain years.

DESCRIPTION.

This insect belongs to the Diptera, or two-winged insects, of which the common house-fly is the best known type. It belongs to the family *Cecidomyiæ*, a large group of minute flies, resembling the crane flies or daddy-long-legs *(Tipulidæ)*, but of diminutive form. They are nearly all gall-flies, the females laying their eggs by means of the soft, extensible end of the body, which slides back and forth like the joints of a telescope. The irritation caused by the egg results in the swelling of the stems of plants, or the formation of tumors or galls on the leaves and buds. The Hessian fly, as we shall see farther on, does not produce true galls in this way, but the presence of the insect in the flax-seed state, between the leaf and the stalk, causes the stem to swell, and the leaves to wither and die.

The female. The body is rather slender, uniformly dark brown, the head is round, but somewhat flattened, the eyes are black, the wings uniformly a dull, smoky brown, while the legs are a paler brown than the rest of the upper side of the body. The body, wings, and legs are provided with fine hair-like scales,

those on the wings being in many cases quite broad and ribbed, somewhat like the scales on the wings of a butterfly or moth. The pale brown antennæ are about half as long as the body: the joints are very distinct, like a string of beads, each one being oval-cylindrical. There are seventeen joints, the two basal ones being large, nearly globular, flattened lengthwise, and nearly half as long as thick, and each of nearly equal size; joints 3–5 are longer than the remaining ones, and are slightly contracted in the middle; the remaining 6–17 gradually decrease in length, each joint being provided with about ten hairs, arranged in a rude whorl: the terminal joint is long and conical. The legs are of the same color as the under side of the body, being a little paler than the back.

The abdomen is rather full, with nine well marked rings or segments, the paler small ovipositor forming the tenth. The latter is one half as thick as the ninth segment, and about two thirds or quite as long; is slightly sinuous, and a little smaller at the end than at the base. The wings are dusky, with a fine fringe around the edge, and there are three veins. The subcostal vein ends near the outer third of the wing; the median vein arises from near the base of the submedian vein, and runs nearly parallel to the subcostal vein, while a branch (its base disconnected with the main vein) extends along the middle of the wing; the submedian vein is well developed, at the base throwing off the median vein at a little distance from the base of the wing, and losing itself before turning down to the edge of the wing. The length of the fly is one tenth of an inch.

The male. The male is rather smaller than the female, being distinguished by the long, slender abdomen, and the longer and more hairy antennæ, which have twenty joints. These are oval, the terminal one conical, and all provided with a few hairs, much longer than in the female, and arranged in a decidedly verticillate manner. "The abdomen in the living specimen is black or brownish black, with bands at the sutures, both above and beneath, of a brick red, tawny yellow, or grayish color, varying in their width as this part of the body is more or less distended." The claspers at the end of the body are stout, —much more so than in *Cecidomyia leguminicola* of the clover.

The egg is very minute, about a fiftieth of an inch long, cylin-

drical, pointed at each end, the shell shining and transparent, the egg being of a pale red color.

The larva. After remaining about four days in the egg state, the larva or maggot of the Hessian fly hatches. The body is soft, smooth, shining, oval cylindrical, beneath a little flattened, and consists of twelve segments besides the head, the latter soft, fleshy, and but slightly separated from the body, with very rudimentary mouth-parts (jaws, etc.). The rings or segments are moderately convex, and tolerably distinct from one another,—the sutures between the segments in the living larva being indicated by faint transverse lines of a greenish-brown hue, according to Fitch, who also states that the mature worm, freshly taken from the roots of the wheat, measures about .15 of an inch in length by .6 of an inch in width. Mr. Riley informs us that there are nine pairs of minute spiricles, which appear as yellowish rounded tubercles.

The puparium or "flax-seed" state. When fully grown the larva is ready to transform into the third or pupa stage of its transformations. The body turns brown, and finally of a bright chestnut color, while the skin loses all appearance of sutures, and assumes a rude, spindle-shaped form, somewhat larger than the larva. This brown case protects the growing pupa within the skin of the latter, finally separating from the cast larva skin, called the pupa-case or *puparium*, and which serves as a sort of cocoon to protect the pale, soft-bodied pupa within. While many two-winged gall-flies are protected by the galls within which they live, others, like the larval wheat and clover-seed midge and the pitch-pine midge, spin true cocoons of silk; and the Hessian fly is the only species of the genus or family, so far as we know, which assumes this puparium state, being peculiar to the house-fly and other specie of Muscidæ and allied families, in which the pupa is said to be *coarctate*, *i. e.*, protected by the cast dried brown skin of the maggot or larva.

From the decided resemblance to a flax-seed, the insect, when at this stage of its transformations, is said to be in the "flax-seed" state. It is, however, rather flatter than a flax-seed, being pinched, as it were, at the head end of the body. I have taken the semi-pupa, or incompletely formed pupa, from the flax-seed December 1st. In this flax-seed state the partly formed

pupa resides during the five winter months of the year. In early spring, during warm weather in April, the semi-pupa rapidly transforms into the complete pupal or chrysalis state.

The pupa. By the time the insect reaches the pupa state the flax-seed case has become quite brittle, breaking asunder transversely if rudely handled, one of its ends slipping off from the insect within, like a thimble from the end of the finger.

The Hessian fly is easily distinguishable, in all its stages, from the wheat midge, which belongs to a different genus, *Diplosis* (*D. tritici* of Kirby). The wheat midge is orange-colored, has a stouter body, with clear, transparent, and much broader wings, and pale yellow legs, while the larvæ are orange-colored, and live crowded around the wheat-grains at the top of the plant. They spin a silk round genuine cocoon, smaller than a mustard-seed, which remains in the ground just beneath the surface. So it will be seen that the forms and habits of the two insects are very dissimilar, and that they need not be confounded.

HABITS.

Having become acquainted with the appearance of this two-winged gall-fly in its different stages, we are now prepared to study its habits; for an intimate knowledge of how it comports itself as an egg, larva, "flax-seed," and perfect winged fly, is absolutely essential to the farmer who would endeavor intelligently to combat this pest.

Number of broods. The Hessian fly is double-brooded, the "flax-seeds," or puparia, being found on the winter wheat from late in the autumn through the winter, until the early part or middle of April. The "flax-seeds" of this brood, from one to about twenty in number, are situated between the stalk and sheathing base of the leaf, at the roots of the young grain, slightly beneath the suface of the ground.

The "flax-seeds" of the second generation affect the wheat in the late spring and summer, but are situated higher up, an inch or two above the surface of the ground, at the lower joints of the straw.

As a general rule, there are two broods of the fly, the first laying their eggs late in April and in May, and the second brood of flies ovipositing in August, during September, and perhaps a

few early in October. Sometimes the flies appear earlier, as Prof. Cook, who observed the insect in Michigan, says that in July and August the flies again issue forth, and the cycle of changes for the year is complete. Thus we see that the flies are ready for work in the fall, much before the wheat is ready for them, and may attack an advance crop long before the usual crop is above ground, or even sown.

A third brood may sometimes appear, as shown by Mr. B. Hulick, of Michigan. According to Prof. Cook, Mr. Hulick found the empty "flax-seeds" on volunteer wheat in September. On Prof. Cook's expressing some doubt whether the fly had issued, suggesting that it might be the parasite that had eaten the fly and come forth, as the time appeared to him too short, Mr. Hulick at once planted some of the volunteer wheat, still containing the "flax-seed," in close jars, and "saw many of the flies issue; and more, had eggs laid by these flies on the same wheat in October. Mr. Hulick showed these flies and their eggs to several of his neighbors. In this case, the eggs were deposited in July, the flax-seed state assumed in September, from which came a third brood of flies in October. This is certainly a very important matter, as it shows that three broods are possible under favorable conditions;—that while the fall flies may, nay, generally must, wait till September to deposit eggs, they only want opportunity to breed their mischief much earlier, even in July or August, and thus propagate a late brood of flies which will be in readiness for even the latest sown wheat. No doubt, too, as in the case of all insects, varying degrees of heat or cold will accelerate or retard the various transformations."

Mode of egg-laying. The mode of oviposition has thus been described by Mr. Herrick: "The eggs are laid in the long creases or furrows of the upper surface of the leaves (*i. e.*, the blade or strap-shaped part) of the young wheat plant. While depositing her eggs the insect stands with her head towards the point or extremity of the leaf, and at various distances between the point and where the leaf joins and surrounds the stalk. The number found on a single leaf varies from a single egg up to thirty, or even more."

Prof. Cook says,—"The fly very rarely lays more than three eggs at one time without change of position. She more fre-

quently lays two, and generally but one. In case she lays but one, it takes less than a quarter of a minute, and less than half a minute to lay three when they are all laid without a change of position on the part of the fly. After laying she seems to draw in her ovipositor, soon to extend it again, at the same time crowding into it the one, two, or three eggs that are next to be laid. She then flies to another leaf, alighting usually—not always—with head towards the end of the leaf. She then appears to wipe the eggs off the jointed ovipositor. She really crowds the egg till the end touches the leaf, when, by friction of the leaf and adhesion of the egg, the latter is held fast while the egg-tube is withdrawn. If the second and third are to be laid, she repeats the operation, after which she retracts her ovipositor, re-stocks it, and in a trice is depositing the fatal germs on another leaf. I say 'usually' on the upper surface, for occasionally eggs are laid on the stalk, and sometimes on the under side of a leaf. I have observed that the fly often makes many unsuccessful efforts to cause the egg to adhere on the outer face of the leaf before she succeeds. I have seen a fly work thus for two minutes before success crowned her efforts. The fly may thus learn by experience that it is easier to deposit on the inner or upper face of the blade, and so generally chooses that surface. We shall see, too, in the sequel, that it is better for the prospective maggot that the egg be placed on the upper surface. In from four to ten days, more or less, as the weather is cool or warm, the eggs hatch."

Mr. C. V. Riley describes as follows the process: "I have very carefully studied the oviposition of the Hessian fly, closely observing the female in the act on several occasions, and as accurate observations on this point are not easily made, I herewith transcribe my notes of several years ago:

"Eggs deposited in irregular rows in the longitudinal cavities and depressions of wheat-stalks, between the stalk and sheath when this is loose, or on the leaves between the natural ridge or carinæ of the upper surface, this last being the more common habit. Ordinarily there are from five to ten in a row, but sometimes more. Each egg .02 inch long, cylindrical, rounded at each end, soft, translucent, and pale orange-red in color. Before hatching, the pale sides of the inclosed larva show through the

shell. Larva hatches in four days; crawls down leaf to base of sheath, which on young grain is at crown of root. The orange-red color is soon lost, and the larva becomes pale, translucent, and plump, sinking more or less into the stalk by the depleting process kept up."

The flies of the second brood are, in southern Michigan, ready to deposit their eggs late in April or early in May, "on spring wheat or barley which is sufficiently advanced, in lieu of which they deposit on the wheat again, not on the basal or radical leaves, but on the leaves which will be above the first or second, rarely the third, joints."

Habits of the larva. As soon as the footless larva or maggot hatches, it makes its way down the leaf to the base of the sheath, which, in the young winter wheat, is at the crown of the root. Here it fastens, lengthwise and head downwards, to the tender stalk, and lives upon the sap. It does not gnaw the stalk, nor does it enter the central cavity thereof, but, as the larva increases in size, it gradually becomes imbedded in the substance of the stalk. After taking its station, the larva moves no more, gradually loses its reddish color and wrinkled appearance, becomes plump and torpid, is at first semi-translucent, and then more and more clouded with intestinal white spots, and when near maturity the middle of the intestinal parts is of a greenish color. In five or six weeks (varying with the season) the larva begins to turn brown, and soon becomes of a bright chestnut color, bearing some resemblance to a flax-seed.

EFFECT OF THE LARVA.

As has been stated, the worm in autumn lies at the sheathing base of the leaves, just above the roots, at or near the surface of the soil. It is easy to detect the flax-seed from its large size and chestnut-brown color, by separating the leaf from the stalk of the young wheat in October and November, when the worm has stopped feeding, and is incased in its brown sack. Scattered shoots will be found, withered and changed to a light yellow color, and, as Fitch observes, strongly contrasting with the rich green of the vigorous uninjured plants. The worms, before assuming the flax-seed state, rest between the leaves and the stalk. Their soft, fleshy, undeveloped mouth-parts do not

enable them to gnaw the surface of the plant, but the sap is supposed to be absorbed directly through the walls of the body, and thus they are said to feed by imbibition. This weakens the plant, and causes it to become unhealthy, turn yellow, and die. Moreover, the presence of the worms causes the formation of a gall-like swelling or enlargement of the stalk, an abnormal growth of the plant being caused by the slight interruption to the flow of the sap. Of course, when six or a dozen of these comparatively large flax-seeds are lodged under the base of the leaves, the plant turns yellow and dies, as if the roots had been affected.

PARASITES.

How useful, nay, indispensable, parasitic insects may prove in keeping the noxious ones within due limits, is well illustrated by the case of this fly, for whenever it suddenly disappears from a given locality, this is usually due to the attacks of its parasites, and especially one Chalcid fly, the *Semiotellus destructor*, first described by Say.

This is a hymenopterous insect, having four wings, and belonging to the same order of insects as the saw-flies, four-winged gall-flies (*Cynips*), the larger ichneumons, and the wasps and bees. It is a member of the family *Chalcidæ*.

So destructive is this and other parasites to the Hessian fly, that, as early as 1841, Herrick claimed that, in Connecticut, "a very large proportion, probably more than nine tenths, of every generation of the Hessian fly is destroyed by parasites." This work is mainly, we doubt not, done by the chalcid parasite under consideration. It is to this insect, more than to any other means in nature, that we owe the general immunity in certain years from the attacks of the Hessian fly in most wheat regions, and to this cause that, during certain years, the fly is kept wholly within bounds. Few people, even naturalists, have any adequate idea of the good done by these minute parasites. What was the fact in Connecticut in 1841, and the few years preceding, has been the case in Michigan.

REMEDIES.

Having become familiar with the habits of this insect, which can be readily observed by farmers, it is not difficult to apply

such remedies as the experience of wheat-raisers of the past century in different parts of the wheat region of the United States has nearly universally found serviceable. Remembering that the first brood of flies appear in August, and continue to hover over the fields until late in September, as if waiting for the fall-sown wheat to appear, it is evident that by delaying the date of sowing until after a frost cold enough to kill the flies, they may be circumvented; for, if the wheat is sown later than the 20th of September in nearly all the Middle and Northern states, the early frosts will destroy these delicate insects. Late sowing, then, is the most general, important, and easily applied preventive remedy.

Late sowing of most of the wheat seed. All writers, both entomological and agricultural, concur in recommending this easily applied remedy,—that at least a part of the wheat should not be sown until after the 20th of September, in the Northern states. The writings of Fitch, Harris, and Cook concur in recommending this course in a district ridden by these pests, even though the wheat is in danger of being injured by the cold autumnal or the winter weather.

It should, however, be borne in mind, that late sowing exposes the wheat to the attacks of the wheat-midge *(Diplosis tritici)* and also to the rust; while, also, by late sowing, the plants are less advanced and less fitted to withstand the rigors of the winter. Still, there are some who adhere to early sowing as, on the whole, the best thing to do.

We conclude that, on the whole, late sowing is the best general remedy; but still a part of the wheat should be sown early, as a decoy to draw off the flies and induce them to lay their eggs in the early sown grain, that the later sown portion may escape their attacks; and then farmers should plow under and resow the fields of early grain.

Advantage of high culture. Many farmers advocate high culture,—sowing a less breadth of wheat, and cultivating the ground, using fertilizers. This is all-important, as the stronger and more luxuriant the growth of the young wheat, the better able will it be to withstand the weakening effects of the maggots; while high culture will carry a partly infested field of wheat through, when the same grain grown on a poorer soil

would succumb. The value, then, of good farming, conducted on scientific principles, the forcing of the plant by fertilizers, and the rotation of crops, is so self-evident that we need devote no more space to this subject.

Pasturing with sheep. Many farmers practice pasturing wheat fields with sheep or cattle; for it is claimed that if the wheat is strong enough by the middle or end of November to bear it, enough of the larvæ or flax-seeds may thus be destroyed to save the wheat and prevent the necessity of plowing it in. This is a rather rude, uncertain remedy, but can be carried on with more or less success in the Middle states.

Sowing of hardy varieties of wheat. When the stalks and leaves of certain varieties of wheat are tough and hard, the stems coarse and silicious, and the plants "tiller," or throw out secondary shoots in a vigorous way, such varieties are naturally the most fly-proof, and should be selected for sowing as winter wheat; while the less hardy and vigorous kinds should be sown when the attacks of the Hessian fly are not to be expected.

Of the different varieties of "fly-proof" wheat, the Underhill variety has, for nearly a century, been highly recommended. As Fitch remarks, its fly-proof qualities were supposed by many to be due to the hardness or solidity of its straw. The fly laid its eggs freely upon the leaves, but it was seldom, if ever, materially injured by it. It is a bearded white chaff, with a plump yellow berry, requiring to be thoroughly dried before grinding, and then producing flour in quantity and quality equal to the best of the other varieties.

SPECIAL REMEDIES.

Under this head belong the use of lime dusted on the young wheat, rolling, deep ploughing, burning the stubble after harvest, etc. Such special remedies as these are of little use as compared with careful preparation of the ground and late sowing, and some of them actually do more harm than good.

Application of lime. It has been frequently recommended to spread fine lime, soot, or salt upon the young wheat, so as to kill the young larvæ. It is evident that such remedies as these should be applied before the insect transforms into the flax-seed state, as the hard, dense pupa case is impervious to ordinary appliances, such as would kill the maggots.

Rolling the ground. Practical men advise rolling the ground, both to keep it moist and in order to destroy the eggs, larvæ, and some of the flax-seeds. This may be, in some cases, worth trying, but we should think that full as much injury would be done to the wheat plants as to the minute larvæ and eggs upon them.

Burning the stubble. Although this remedy has been advocated, it will be seen to be worse than useless when we reflect that after all the artificial means taken to reduce the number of the Hessian fly, nature's method of checking its undue increase is far more important and thorough-going: we refer to the diffusion and multiplication of the insect parasites. As previously stated, most probably nine tenths of the young Hessian flies are destroyed in the larva or pupa state by the parasites already described. For the most part, these parasites live in the flax-seeds contained in the straw, and appear in spring. Now, to burn the stubble in the autumn or early spring is simply to destroy these useful parasites, the best friends of the farmer. We do not hesitate to urge that the straw be untouched. On the contrary, the parasites should be gathered and bred in numbers; and we believe that practical entomologists should bend all their energies towards clearing up the subject of rearing and multiplying these insect hosts. Much knowledge and practical skill is needed in this direction, as occasionally by disseminating the parasites their noxious hosts may increase and be distributed; but knowing, as we do, how many more of the parasites are in many cases bred than the insects on which they prey, it seems safe and reasonable to advise not only not burning the stubble, but letting it stand; so that the parasites may finish their transformations, become fledged, and ready, when the eggs and larvæ of the Hessian fly are upon or in the young wheat, to destroy them.

It is a matter of fact, that, in years when the Hessian fly is specially abundant and destructive, similar seasons are highly favorable to the corresponding increase in the number of their insect or ichneumon parasites: they do their work so effectively that the few following years the numbers of Hessian flies are greatly reduced. It is, then, to these parasites that we are indebted for the years of immunity from the attacks of the Hes-

sian fly, as much as to favorable or unfavorable weather; and this leads us to consider the apparent *periodicity* in the years of abundance and scarcity of the Hessian fly.

PERIODICITY.

All insects, especially the more noxious ones, those which fall under common observation,—such as the locust, cotton-worm, army-worm, chinch-bug, and the like,—have their years of undue numerical increase and of unusual scarcity. This periodicity is, without doubt, partly owing to the influence of the weather, of favorable and unfavorable seasons, and partly, in most cases, to the absence or abundance of the insect parasites; although the latter cause is largely influenced by climatic agencies.

As the recorded facts indicate, within about ninety years there have been, in the Atlantic and Middle states, six periods of unusual abundance, namely, centering about the years 1790, 1817, 1844–'45, 1871–'72, and 1876–'78. These dates mark the time of culmination in the degree of abundance and extent of ravages committed, and were preceded by from one to several years of less or greater abundance. After the culmination, or year of greatest abundance, the fly often suddenly disappears. This sudden disappearance is, without doubt, due to the great increase in the number of parasites; while the original increase is probably due to a succession of warm, damp seasons, favorable to the multiplication of the flies. These seasons, when we look at the later Hessian fly years, such as 1844–'45, 1871–'72, and 1876–'78, when the insect had become wide-spread over the western portion of the wheat area, were evidently areas of similar climatic features common to the Atlantic and Mississippi Valley states. Whether these seasons were warm and moist or not, we have not the means at hand to enable us to form an opinion. We simply, at this time, draw attention to the great desirability of putting on record the amount of correspondence between the meteorological conditions of the seasons of undue increase or unusual scarcity of insect pests, in order that we may be able, in the future, to make some calculations as to their probable increase or decrease, that farmers and gardeners may govern themselves accordingly.

DISTRIBUTION.

There is little doubt but that this insect was, as stated first by Col. George Morgan, of Prospect, N. J., and afterwards by Mr. Herrick and Dr. Fitch, introduced from Europe. That it was originally a European insect is shown by Mr. Herrick, who quotes a writer as authority for the statement that the insect was injurious to wheat near Geneva, in May, 1732, and again in May, 1755. It was also detected by Prof. J. D. Dana, in the spring of 1834, who found the larvæ, pupæ, and reared the flies from wheat growing on the island of Minorca. He sent several pupæ and flies from Mahon to Mr. Herrick, who identified them as the Hessian fly. As he writes, "the Mahonese asserted that the insect had been there from time immemorial, and often did great damage, both there and in Spain." Dana also collected the same insect at Naples, and also at Toulon, France. It seems, also, that this insect, or one very closely allied to it, injured the wheat in Hungary at or about the same date as Mr. Dana's visit to Europe, *i. e.*, 1834.

Like some other insects introduced from Europe, which there are only slightly injurious, the *Cecidomyia destructor* here became *prepotent*, *i. e.*, multiplied to an unusual degree, and became alarmingly prevalent; while in Europe it had not even been described by entomologists, its local ravages having been mostly confined to areas not visited, apparently, by entomological students.

With Herrick, Fitch, and others, we are disposed to credit the belief of Col. Morgan, that this fly was introduced in America in the straw used for packing, brought by the Hessian troops during the Revolutionary war. These troops were landed on Staten and the west end of Long Island, August, 1776. This, then, was the starting-point from which the fly originated, and it will be interesting to learn how it spread to its present limits, how rapidly, and whether it is at all migratory. Our knowledge on these points will be mainly derived from Fitch's report and subsequent publications.

Does the Hessian fly migrate? As regards the so-called migrations of this insect, we would express our disbelief in any such movement from place to place as is involved in the idea of the word "migration." The history of the insect simply shows

that it has steadily spread from its original point of introduction to new sections of the country as rapidly as they were settled and wheat became a staple article of production. It is periodically abundant, much as most other obnoxious insects are,—more abundant some years than others; becoming abundant at some localities and scarce at others. It cannot, therefore, truly be said to "migrate" from one part of a state to another, or from one natural region to another.

SUMMARY.

1. There are two broods of the fly, the first laying their eggs on the leaves of the young wheat from early April till the end of May, the time varying with the latitude and weather; the second brood appearing during August and the early part of September, and laying about thirty eggs on the leaves of the young winter wheat.

2. The eggs hatch in about four days after they are laid. Several of the maggots or larvæ make their way down to the sheathing base of the leaf, and remain between the base of the leaves and the stem near the roots, causing the stalk to swell and the plant to turn yellow and die. By the end of November, or from thirty to forty days after the wheat is sown, they assume the "flax-seed" state, and may, on removing the lower leaves, be found as little brown, oval, cylindrical, smooth bodies, a little smaller than grains of rice. They remain in the wheat until during warm weather. In April the larva rapidly transforms into the pupa within its flax-seed skin, the fly emerging from the flax-seed case about the end of April. The eggs laid by this first or spring brood of flies soon hatch; the second brood of maggots live but a few weeks, the flax-seed state is soon undergone, and the autumn or second brood of flies appear in August. (In some cases there may be two autumn broods, the earliest August brood giving rise to a third set of flies in September.)

3. There are several destructive ichneumon parasites of the Hessian fly, whose combined attacks are supposed at times to destroy about nine tenths of all the flies hatched. Of these, the most important is the Chalcid four-winged fly *(Semiotellus destructor)* which infests the flax-seed.

4. By sowing a part of the wheat early, and if affected by the fly, ploughing and sowing the rest after September 20, the wheat crop may, in most cases, be saved. It should be remembered that the *first* brood should be thus circumvented or destroyed in order that a second or spring brood may not appear.

5. If the wheat be only partially affected, it may be saved by fertilizers and careful cultivation; or a badly damaged field of winter wheat may thus be recuperated in the spring.

6. Pasturing with sheep, and consequent close cropping of the winter wheat in November and early December, may cause many of the eggs, larvæ, and flax-seeds to be destroyed; also, rolling the ground may have nearly the same effect.

7. Sowing hardy varieties. The Underhill Mediterranean wheat, and especially the Lancaster variety, which tillers vigorously, should be sown in preference to the slighter, less vigorous kinds, in a region much infested by the fly. The early (August) sown wheat might be Diehl; the late sown, Lancaster or Clawson.

8. Of special remedies, the use of lime, soot, or salt may be recommended, also raking off the stubble; but too close cutting of the wheat and burning the stubble are of doubtful use, as this destroys the useful parasites as well as the flies.

A COMPLETE MILK RECORD.

BY THE SECRETARY.

A few years ago several gentlemen in Concord and the vicinity organized under the name of the Concord Land & Water-Power Company, purchased several farms in the neighborhood of Sewall's Falls bridge, mostly on the west side of the Merrimack, with the view of establishing some profitable class of manufacture there. But it was a thing of the future. In the meantime, not desiring to lose the interest on their purchase, the company utilized the lands and buildings by keeping a large milking stock, and selling milk in the Concord market.

There are about 450 acres on the west side of the river, and half as much on the east. The soil is not a fertile one, being a sandy loam, with clay bottom in some sections.

The company have kept an indefinite number of cows, varying from twenty-five to twice or perhaps three times that number. Under the general supervision of Mr. C. T. Page, no cow is suffered to remain long on the farm, unless she will "pay her way" and give a profit. Hence the number and character of the herd are constantly varying. When one falls below a given standard, she is sold, or put into beef, and her place filled by others, until a satisfactory record is secured.

They feed hay, but not to such an extent as most farmers, grow much for which the soil is adapted, and put many tons into silos, which is regarded as the most economical method of preserving the forage.

Mr. Page prefers to put corn that is nearly matured into ensilage, as he saves the full value of the crop, the advanced and partially matured grain making a feed admirably adapted to the production of milk. In connection with this feed he uses hay and cotton-seed meal.

Milk Record of Cows at Merrimack

Number.	Age.	Breed.	Calved.	Dried.	Milk product,—quarts.
1	12	Native.	Feb. 13,'82	Dec. 10,'82	For 1 yr.....2,740.
2	8	"	Dec. 31,'81	Sept. 20,'82	" 1 yr. from Feb. 1,'82–Feb. 1,'83.. 3,145.
4	6	"	March 3,'82	.....	" 11 mos.....2,380.
5	7	"	Aug. 20,'81	Sept. 26,'82	" 1 yr. from Feb. 1,'82–Feb. 1,'83..2,960.
6	6	"	Dec. 20,'81	Oct. 11,'82	" 1 yr. from Feb. 1,'82–Feb. 1,'83...3,320.
10	6	"	Feb. 27,'82	.....	" 11 mos.....2,660.
11	10	"	June 13,'82	Oct. 15,'82	" 1 yr. from Feb. 1,'82–Feb. 1,'83...3,350.
12	12	Gr. Ayrshire.	Dec. 15,'81	Oct. 11,'82	" 1 yr. from Feb. 1,'82–Feb. 1,'83...3,560.
13	9	Native.	Feb. 21,'82	.....	" 1 yr.....2,800.
16	9	"	Sept. 1,'81	June 5,'82	" 1 yr. from Feb. 1,'82–Feb. 1,'83...2,980.
17	..	Polled.	Feb. 9,'82	.....	" 1 yr.....3,440.
18	3	Native.	.....	.....	" 1 yr. from Feb. 1,'82–Feb. 1,'83...2,080.
25	9	"	Jan 1,'82	Sept. 20,'82	" 1 yr. from Feb. 1,'82–Feb. 1,'83...2,472.
27	4	"	Sept., '81	" "	" 1 yr. from Feb. 1,'82–Feb. 1,'83...1,800.
34	7	"	Sept. 8,'82	.....	" 1 yr. from Feb. 1,'82–Feb. 1,'83...1,968.
38	11	"	Nov. 25,'81	Oct. 23,'82	" 1 yr. from Mar. 1,'82–Mar. 1,'83..2,728.
41	8	Durham.	May 3,'82	.....	" 1 yr.....2,800.
42	11	Gr. Dutch.	March 2,'82	Dec. 4,'82	" 1 yr. from Mar.,'82–Mar.,'83.....1,960.
44	9	Gr. Jersey.	Nov., '81	May 12,'83	" 1 yr. from Mar.,'82–Mar.,'83.... 2,615.
52	4	Gr. Devon.	March 2,'82	Dec. 3,'82	" 1 yr. from Mar.,'82–Mar.,'83.....2,155.
53	5	Dutch.	March 7,'82	Mar. 27,'83	" 1 yr. from Mar.,'82–Mar.,'83.....2,950.
64	8	Native.	April 1,'82	May 29,'83	" 1 yr. from June 15,'82–June 15,'83.2,336.
66	6	"	June 28,'82	.....	" 1 yr. from July 1,'82–July 1,'83...3,425.
69	9	"	May 1,'82	Feb. 27,'83	" 1 yr. from July 14,'82–July 14,'83..2,440.
71	8	"	April 1,'82	Feb. 27,'83	" 1 yr. from July–July.....2,315.
73	4	Gr. Dutch.	July 15,'82	.....	" 1 yr.....2,830.
78	9	Native.	Sept. 2,'82	Dec. 1,'83	" 1 yr. from Sept.,'82–Sept.,'83....4,400.

Farm, Sewell's Falls, Concord, N. H.

Calved.	Dried.	Remarks.
Feb. 5, 1883	.....	From Feb. 5 to Dec. 1, 1883, yield 3,240 qts.; Dec. 1, average 9 qts. per day; farrow, and will go to butcher on account of age.
Nov. 19, 1882	.....	
.....	.....	This cow did not do well enough to keep, and was sold for beef.
Nov. 1, 1882	Oct. 6, 1883	Calved again Nov. 13, 1883; yield from Feb. 1, 1883, to Dec. 1, 1883, 2,384 qts; yield, Dec. 1, 1883, averages 18 qts. per day.
Nov. 4, 1882	.....	Sold.
.....	.....	Sold Jan. 22, 1883.
Nov. 19, 1882	.....	Sold June 28, 1883, when giving an average of 9½ qts.
Nov. 5, 1882	Oct. 6, 1883	Calved again Nov. 5, 1883, yielding Dec. 1, 1883, an average of 16 qts.
.....	Aug. 22, 1883	Sold March 20, 1883.
July 27, 1882	.....	Calved again Oct. 5, 1883; yield for Oct. and Nov., 15½ qts.
....	.....	Sold April 28, 1883.
.....	.....	When record began, this heifer was giving but little; dried May 1, 1882; calved July 6, 1882.
Nov. 9, 1882	.....	Sold Nov. 13, 1883.
Nov. 13, 1882	.....	
.....	.....	Sold April 14, 1883.
Dec. 12, 1882	.....	Sold July 10, 1883.
.....	.....	Sold May 22, 1883.
Feb. 22, 1883	.....	Sold March 9, 1883.
Aug. 23, 1883	.....	Dec. 1, 1883, yielding 11 qts.
March 3, 1883	.....	
June 9, 1883	.....	" " " "
Aug. 17, 1883	.....	" " 10 "
.....	.....	Sold Nov. 30, 1883.
April 16, 1883	.....	
March 25, 1883	.....	Sold Nov. 21, 1883.
.....	.....	Sold July 17, 1883.
.....	.....	Due to calve Jan. 30, 1884.

The company now run three milk teams to Concord, and furnish an excellent quality of milk, having only a short distance to carry it, and sending it in directly after milking. At least one half the time there is no lack of paying patrons. They sell canned milk, produced only by vigorous and healthy cows in a uniform condition. This is sought for at an advanced price by those families who have young children to feed, and those who are especially particular about a uniform quality of milk.

They keep no other stock than cows, except to carry on the farm work. They have not yet made attempts at experimentation on their farm, though they are constantly putting new practices to the test.

Before long the company will build a dam, and perhaps construct a canal and designate sites for mill privileges. They are now negotiating with regard to flowage on lands not owned by the company. They have made surveys, and know every acre for miles above them that will be flowed.

Years ago (forty or more) a dam was constructed across the Merrimack near the upper end of Sewall's Island, and a canal partially made to a point just east of Federal Bridge, with the hope of building up a manufacturing interest at East Concord. But the project failed to meet the expectation of its originators, and was abandoned before large sums were invested.

Our object in naming the enterprise of the Concord Land and Water-Power Company is to give a lesson to the dairymen of the state, and, indeed, to all farmers who make milk or butter an element in their occupation.

The preceding table explains itself, and shows how simple a thing it is to ascertain by their products the profitable and the unprofitable animals in the herd.

Not only this, but as this herd has not only natives, but Short-Horns, Dutch, Polled, and grades of various unions, the table is an index of their capacities is one direction. It is made up by records kept, day by day, by the farmer on the premises, and returned on special blanks prepared for the purpose to Mr. Page, who transfers them to a permanent record, an abstract of which he has furnished the secretary.

THE RAILROAD WORM.

Within a year or two the early ripened apples, in this state and in other New England states, have been seriously injured by a small maggot, about one fourth of an inch long, that bores through the flesh and causes decay to follow. In many cases the apple is wholly spoiled by the inroads made upon it. It has the past year attacked even the Baldwin and other standard fruits, to the great injury of the orchardist. Externally the apple appears to be sound, and is gathered and packed with the belief that it is perfectly sound. But when the barrels are opened and the apple is placed upon the table for dessert, it is soon found to be completely tunnelled by the enemy. It has commonly been called the railroad worm, as it is supposed to have been brought to this section by the railroad trains.

According to Prof. Riley, the United States entomologist, the insect was first noticed by naturalists, in 1865 or 1866, in Illinois. A description of it was given at that time, and afterwards a full history so far as known. Its native habitat is the crab-apple or the hawthorn. In the Agricultural Report for 1882 is a paper on the insect, by Prof. Comstock of Cornell University. He denominates it the apple-maggot, the *Trypeta pomonella* of Walsh.

The professor describes it as "eating into the pulp of apples and causing them to decay,—a white cylindrical maggot, which, when full grown, goes into the ground to transform. The adult is a black-and-white fly with banded wings." The maggot is a small, white, footless larva, measuring from 19-100 to 27-100 of an inch, sometimes having a yellowish and again a greenish tinge. It tunnels the flesh of the fruit in all directions, not unfrequently enlarging the roads to the diameter of a fourth of an inch. The entire pulp is often honey-combed. It is a

native of America, originating and formerly feeding on the flower or fruit of the hawthorn and the crab-apple. It has probably accompanied these shrubs for years, but has not until recently preyed on the cultivated apple. It is now a positive pest, and threatens our apple-growing sections. The full description of the insect and its habits is taken from the Report of the Commissioner of Agriculture for 1881–'82:

Larva.—According to my observations and all published accounts (says Prof. Comstock), the apple maggot does not occur in the apple till the latter part of the summer. The caudal two thirds of the body is cylindrical; the cephalic one third tapers slightly to the head, which is the smallest segment of the body. On the dorsal surface of the body there is on each side, at the union of the first and second segments, a pale-brown tubercle. These are the cephalic spiracles. The structure of these spiracles is quite complicated. Each one is expanded into a plate, the free margin of which is fringed by a double series of cylindrical projections, about twenty in number. With a very high power of the microscope the distal end of each of these projections appears to be sieve-like—an arrangement which doubtless prevents the entrance of any foreign matter into the respiratory system. With a low magnifying power the main tracheæ connected with these spiracles may be seen. A single large trunk on each side extends the whole length of the body. These are connected near each end of the body by a large transverse trunk. Many of the smaller tracheæ which branch from the main tracheæ are usually visible. The caudal end of each of the two main tracheæ opens by means of a very complicated spiracle. These differ much in structure from the cephalic spiracles, and are situated on the last segment of the body. There are three transverse slit-like openings, which are fringed by a series of teeth, which are apparently chitinous. The function of these teeth is doubtless the same as that of the sieve-like membrane closing the ends of the tubular projections of the cephalic spiracles. Each of the caudal spiracles is accompanied by four groups of bristles, two upon the lateral side and one each upon the cephalic and caudal sides.

The caudal end of the body is obliquely truncate, the ventral part projecting farther than the dorsal part. This sloping part

of the body bears four pairs of tubercles. One pair of these is more prominent than the others.

The mouth is armed with two black, strong, curved parallel hooks, which are used in rasping the food. The hooks are connected with an internal, apparently chitinous, framework, which is also black. These black oral hooks and the two pairs of spiracles, both of which are brown, are visible to the unaided eye, but their structure can only be made out by the aid of the microscope.

Pupa.—In the autumn when the larvæ are full-grown, they leave the apple and enter the ground and transform to pupæ. In my breeding-cages the pupæ were found about one half inch below the surface of the ground. When the change to pupa occurs the body shortens, but the larval skin is not molted, the transformation occurring within the dried skin of the larva. The pupa, therefore, resembles the larva very much, except that it is shorter, of an oval outline, and of a pale yellowish-brown color. Length about one fifth inch.

Adult.—The insect remains in the pupa state during the entire winter and early summer. Specimens which I bred in Washington began to emerge as adults May 28, and continued to emerge till July 6. But as these were kept in a warm room during the entire winter their development was doubtless accelerated.

The actual length of the body of the male is one fifth inch; of the female, one fourth inch. This fly can be easily recognized by the peculiar shape of the black bands on the wings, by the milk-white spot on the caudal part of the thorax (scutellum), and by the white bands on the abdomen. A more detailed description follows:

The head is rust-red, with the eyes and the bristles black. The thorax is black, with a white stripe on each side, and two silvery stripes on the dorsal aspect; scutellum white except at base. The abdomen is black, with transverse silvery stripes above; of these there are in the male three conspicuous ones, making the caudal margins of the second, third, and fourth segments; in the female there are four, which are less conspicuous, and are borne by the first to the fourth segments inclusive. The shape of the abdomen differs also in the two sexes. In the

male, the segments successively widen to the fourth. The margins of the first to the fourth segments form two divergent and nearly straight lines. In the female the abdomen suddenly enlarges, so that the second segment is the widest, and the outline of the whole abdomen is elliptical. The legs are pale rust-red; the four posterior femora, except at the proximal ends, are brownish black. The wings are hyaline, with four black cross-bands; the first, which is near the proximal end of the wing, is confluent with the second near the caudal border of the wing; the second, third, and fourth are confluent near the cephalic margin of the wing and diverge caudal.

Remedies.—The more practicable ways of lessening the injuries caused by this pest are the destruction of infested fruit promptly after its fall from the tree, and before the maggots leave it to go into the ground to transform; and when the pest is very abundant, the grafting of the trees into varieties less liable to be infested. In such a case it might be well to leave one or two trees of early apples to serve as traps, and promptly destroy the fruit as it falls from them. If such trees could be inclosed, and sheep or pigs pastured under them, the success of the trap would be assured.

The apple maggot can be readily distinguished from the larva of the codlin moth by the absence of feet, and the fact that it infests the pulp rather than the vicinity of the core. But there are other maggots which are associated with this species, and with the larva of the codlin moth also, which are not readily distinguished from the true apple maggot. These other species pertain to the genus *Drosophila*, and feed upon decaying fruit. They cannot be considered, therefore, under ordinary circumstances, as noxious insects in an orchard. Two species of this genus are described in the following articles, under the name of *Pomace Flies.*

THE VINE-LOVING POMACE-FLY.

A small white maggot, found abundantly in decaying apples, and producing a small, clear-winged, red-eyed fly.

While studying the apple maggot *(Trypeta pomonella)* just described, I found associated with it two kinds of smaller and more slender maggots, which, so far as my observations go, feed

only on the decaying part of the apple, following the apple maggot in its work of destruction.

As these maggots are the young of flies which in all stages are very common about the refuse of cider-mills and fermenting vats of grape pomace, I have called them Pomace-Flies. And I have distinguished the two species studied by prefixing to that name in each case a translation of the specific name. Thus, one which bears the technical name *Drosophila ampelophila* may be known as the Vine-Loving Pomace-Fly; and the other, which is *Drosophila amœna*, may be called the Pretty Pomace-Fly. I have preferred the term Pomace-Fly to a translation of the generic name, as being both shorter and more characteristic than "moisture-loving flies."

Although, under ordinary circumstances, the Pomace-Flies feed only on decaying fruit in an orchard, and cannot on this account be considered as pests of the apple, there are cases in which they become quite noxious. They are, therefore, worthy of consideration in this place. Moreover, it is important that the Pomace-Flies should be described in connection with the apple maggot, as they are very liable to be mistaken for it; and a mistake of this kind might cause a fruit-grower a great deal of unnecessary trouble.

The Pomace-Flies may be found in any orchard during the autumn, flying about the rotten apples: and their larvæ may usually be seen feeding in great numbers in the decayed fruit. They go through their transformations very rapidly, so that there are several generations in a single season. Numerous observations show the following to be the periods of the different stages of the Vine-Loving Pomace-Fly during the month of October. Duration of egg state, three to five days; of larval state, three to five days, usually four; of pupal state, three to five days also; and the time which elapsed between the emerging of the flies and the beginning of laying eggs, in some cases, was not more than two days.

This rapidity of multiplication greatly increases the seriousness of the evil where this insect is a pest: and this is very apt to be the case wherever fruit is ground up or crushed and exposed. Thus they abound about cider-mills, where often it is almost impossible to prevent the flies from ovipositing in the

pomace or from falling into the cider. The wine-makers also find them a nuisance about fermenting vats of grape pomace, and about wine faucets in the summer.

The larvæ of this fly completely eat out the inside of grapes, which, while hanging on the vines, have first been picked open by birds. The decaying juices, running out on the other berries of the cluster, spread decay, and thus give more foothold for the larvæ. Indeed, the larvæ bore from one grape to another, while the imagos are constantly, by eggs, putting in new colonies until the cluster is nearly or quite destroyed, nothing remaining but the empty grape-skins.

THE PRETTY POMACE-FLY.

A small white maggot, resembling the larva of the Vine-Loving Pomace-Fly, and, like that species, found in decaying apples, but unlike that species in going into the ground to transform, and developing into a red-eyed fly with black spots on its wings.

Associated with the Vine-Loving Pomace-Fly I found another species belonging to the same genus, the *Drosophila amœna* of Loew. For this I propose the popular name of Pretty Pomace-Fly. This species I have not found as abundantly as *D. ampelophila;* but as it is also associated with the apple maggot *(Trypeta)*, it is liable to be mistaken for that species.

ALDERNEYS AND GUERNSEYS.

BY EDWARD P. FOWLER.

The general preference which has been shown of late years for the cows of Alderney and Guernsey, as producing a higher quality of milk for dairy purposes than other breeds, has induced the author, as well from his own conviction of necessity as from the suggestions of friends who have felt the want of such a treatise, to place the following epitome of his knowledge and experience before the public.

Until very recently an impression has much prevailed that the cow of the Channel Islands was unfitted, by its apparently delicate appearance and blood-like breeding, for the use of such persons as were unable to bestow on it the most assiduous attention and care; but experience and a more intimate acquaintance with the animal have shown that this impression is entirely without foundation, and we now constantly see the Alderney cow thriving under circumstances that would be fitting for any other cow kept for the same purpose—viz., milking and breeding.

The Channel Islands cow will be found invaluable for private family use, from its docility, easy pasturage, and small consumption, in comparison with the peculiar richness of its milk, the average in a dairy of forty cows, under such management as is hereafter set forth, having been ten pounds of butter from each cow per week; whereas in other dairies not more than from six to seven pounds is producible from the ordinary milch cow, where alone quantity of milk has been desired, which is not the main object in a private family.

We have, therefore, in the animal under consideration the triple advantage, as before stated, of a symmetry of form which

renders it an ornament to the gentleman's lawn and paddock; a docility which makes it quiet under the tether and in the hands of the milker, whether male or female; and a richness of production which not only fills the dairy with butter, but that of a firmness which it retains in the heat of the summer, and a richness through the cold of winter, when the butter of the ordinary cow is barely marketable.

The prejudice against the Alderney, which has existed amongst dairy farmers whose object is only profit by whatever legitimate means obtainable, is also now fast wearing away, there being scarcely one such in England who does not have a certain proportion of these cattle among his stock, experience having proved that the introduction of the Alderney or Guernsey (especially the latter), in the proportion of one to six other cows, has so improved the character of the dairy, that from two to four cents per pound in advance is obtained in any market, besides the *prestige* which the best commodity will always command.

The preëminent utility of the Alderney cow as a cross in breeding with the Long-horn is universally allowed where the dairy is the object. For this purpose the Alderney is superior to the Guernsey, although the milk of the Guernsey is preferable to the Alderney for mixing in the dairy. The reasons which indicate the cross above mentioned are, on the part of the Long-horn, its large quantity of milk, strength of constitution, longevity, and indisposition to fatten in a breeding state; and on the part of the Alderney, its rich quality of milk, fine breeding, and kind and quiet disposition.

The cow needed for the dairy cannot, under any circumstances, be selected for those qualities which will produce fat: the two natures are incompatible. To have the best meat, we must get rid of every tendency to milk; and to have the best butter, we must obviate every disposition to fatten. We cannot have both qualities in the same animal, and the attempt will only end in disappointment.

The results, then, of the above remarks are these,—that in the first place the Alderney cow is, above all others, especially the cow for the gentleman's lawn and paddock, and the only means by which the dairy farmer may revert to the peculiar and im-

portant principle, so long lost sight of, which places breed beyond bulk, and was contemplated in the old adage, that says,

"The cow to breed,
The ox to feed."

Having expatiated on the peculiar fitness of the Guernsey and Alderney cow for the purposes of milking and breeding, it follows that I should now give such instructions to purchasers as may enable them to choose a good, serviceable animal.

Commencing with the general configuration, it is necessary to observe, that, as the cow under consideration is a high-bred animal, very nearly the same general characteristics should be observed as exist in a well-bred horse.

The head should be small, slender, and lengthy from the eye to the nose; the horns thin and open, not cramped, or, as it is frequently expressed, too curly; the eye full, but not too prominent, the latter quality indicating an excitability and consequent restlessness of disposition that is not favorable to the production of milk; the ear lengthy and broad, and well fringed with hair, which protects it from the annoyance of flies and indicates a strong constitution. A broad muzzle should be avoided, as showing a tendency to fat. The neck should be long, flat, and narrow, with a tendency to rise at the withers, and breadth behind the arm to allow of a full expansion of the lungs, the chest being rather deep than broad; the flat-sided cow is more especially chosen as a milker. The hips should be wide, rugged, and high, the pelvis or haunches, wide and large, drooping toward the tail; the thigh long and lean from hip to hock, the veins being prominent and easily felt; the legs slender, with flat bone; and small, flat feet, the hinder ones having good width between, to afford room for the udder. A long and thin tail is a great point in breeding.

I now come to the udder, to which all former remarks are secondary. This part, the reservoir of the milk, should be free from hair, flexible, and soft, with no tendency to flesh; the bag extending well forward, as level as possible with the belly, and high up between the thighs. The feeding veins should be particularly observed. In the heifer with the first calf, they must be felt for with the hand; in this case two holes will be discov-

ered by feeling under the belly nearly in a line with the navel, on each side, in good milking heifers, of about the size of a dime. As age increases, the holes extend and the veins become large and easily perceived by the eye; the larger these feeding veins appear, the greater is the quantity of milk. The teats should be well separated, not fat or fleshy, and not too long, but sufficiently tight to retain the milk, having a tendency downward,—that is, to use the technical term, not *strutting*, or pointing away from the quarters, as this causes waste of milk and difficulty in milking. These particulars combine all that in ordinary use require to be attended to in the selection of a serviceable cow. There are, however, some few remarks to be made on the skin, which will be found useful in determining the fitness of particular cows for particular localities, but having little to do with the milking properties. If possible, it is better to accustom a cow to cold and exposure by degrees, in which case the skin will adapt itself to the altered condition by thickening and producing more hair; but when this gradual adaptation of the animal to a new and more severe climate is impracticable, choice should not be made of one possessing that great delicacy of skin and covering which is so much coveted, but of one having coarser and more curly hair, and thicker hide, which features are indicative of a customary exposure, when the other points show good milking properties.

It must be apparent to every thinking person, that all the before-mentioned qualities, even in the highest perfection, will not insure an abundant and rich supply of milk unless proper care is taken to furnish the cow with the kind of food best calculated to the required purpose. How often is it found that complaint is made by one person that such a cow is a bad milker, when the same animal transferred to other hands has given every satisfaction! This is easily explained by the fact that in the first case the cow has been kept on foul pasture or on improper food. It becomes, therefore, peculiarly necessary to set forth the manner of feeding which experience has proved to be the most advantageous for the production of rich and sweet milk.

The first requisite in feeding is, that the animal should have abundance of food, so as to be able to consume all that she

requires in as short a time as possible, as then she will lie down and have the more time to secrete her milk, and that milk to acquire richness. The pasture should be often changed, and if not in pasture the food should be succulent, otherwise fat instead of milk will be produced; but cows fed with food of too watery a nature, which is the case with roots early in the season, require an addition of more solid food, such as meal or good clover chaff, otherwise the milk, although considerable in quantity, will be poor and wheyey, yielding no cream. Such roots should be carefully selected as have no symptoms of decay or rottenness, and should be mild in flavor, or the butter will be tainted. In very cold weather, and as a change of food, use crushed linseed and bruised oats, steamed or boiled.

Mangel-wurzel, which has become, from its luscious qualities, so favorite a food for the dairy cow, requires much care and judgment in its use, and should never be given before the month of January, as the longer it is kept the less acidity is produced by it; and even then, in my opinion, it should always be accompanied with from four to six pounds of barley meal or bean meal to every bushel, to correct the irritation occasioned by its sole use, many dairies of good cows having, within my own knowledge, been weakened so as to cause disease and barrenness for want of the adoption of this principle. The best, and in fact the only, roots that should be given are carrots, the yellow turnip, and mangel, succeeding each other from the time they are required till the cow returns to pasture. Brewers' grains and mangel-wurzel are only to be used when a large quantity of milk, in which quality is not sought, is desired. Many cow-keepers in London feed with these for that purpose, and are, in consequence, though selling a genuine article, wrongly accused of diluting the milk. It must be obvious, therefore, that such food is useless for the purpose of producing cream and butter. I consider brewers' grains utterly inadmissible for the dairy cow, and mangel only to be used in the manner before stated as a change of diet.

The cow and the horse can well pasture together, but no other animal should be allowed to run in the same field, pigs and poultry spoiling and tainting the feed. All rank weeds must be carefully eradicated, especially shrubs, yew-hedge cuttings, etc.,

these things being often poisonous, and occasioning the cow to slip her calf. The same remark will apply to dead and putrid matter.

Let the pasture be free from ponds or other dirty drinking-places, where the water is fouled and rendered unwholesome by decayed matter or the drainage from dung-heaps, and by the habit which cattle have of standing and manuring in it for hours together. A clean tub or tank should be used for watering the cattle, and kept supplied with pure, sweet water, which, if pumped from a well, should be exposed to the air a considerable time before use.

Cows should be taken in about sunset, or before they are preparing to rest for the night, and on no account allow them to be hurried to or from pasture, especially when full of milk.

The proper *management* of milking cows is no less necessary than proper *food*.

It should be always borne in mind that the animal whose capabilities are for milking becomes lean on the same quantity of food as will make the feeding cattle fat. The consequence of this is that the milking and therefore lean cow is more affected by changes of temperature than the feeding or fat one.

It follows that in the successful management of the milch cow great care should be taken to avoid rapid and considerable changes of temperature, as well as damp or strong clay land. There should always be a clean, dry shed in which cattle may take shelter whenever they feel uncomfortable, either from heat and flies or from cold and damp. This shed should be so constructed that it may to a certain extent clean itself by drainage, to avoid the accumulation of foul water, the floor being constructed of materials of a dry nature. The aspect should be such as to avoid north and north-easterly winds.

An animal always cold is always uncomfortable, and a large proportion of the food she takes is consumed in keeping up the heat of the body, instead of making milk; warmth is therefore, in effect, food for the cow, and may be obtained at little cost and with little trouble by means of a shed, as recommended; and where this is dry and clean, the cow will resort to it spontaneously whenever she knows it to be conducive to her warmth, which, as above said, is her food to a great extent. Cold and

sudden chills, on the other hand, are a great detriment to the appearance of the cow, and are frequently the cause of her falling off in her milk so early in the season.

So important is it to provide against great alteration of temperature that the impossibility of doing this in large pastures has within the last few years engendered the lung disease which has been so destructive among cattle. Formerly, pastures were small in extent and defended by large and thick hedge-rows as well as trees, but the practice latterly having been to open the fields and to divest them of everything which could form a shelter for the cattle, what has been gained in increasing the quantity of feed has been lost by the disease which the inclemency of an unsheltered field has engendered. It is much to be questioned whether nature was not the best judge, after all.

Much injury is likewise done by turning cattle out too early in the season, exchanging them from a warm yard or shed, especially, just after calving, to pass the night in the open air before the season is sufficiently advanced to make such exposure bearable.

In proportion as the breed of cattle has improved, so has the necessity of care become apparent, delicacy of constitution and physical sensitiveness always increasing with high blood. As a principle of economy I strongly advocate the practice, which is lately gaining ground, of bringing milch cows in at night *all through the year*, for they spoil much grass, especially in full, strong pasture, during the night, and are not benefited by being in the dewy grass too early in the morning; the manure also would be in the yard where it is valuable, instead of under the hedge where it is lost, and where the cattle would naturally lie for protection.

During the winter, when tied up in stalls, great advantage is derived from thoroughly cleaning the cattle occasionally with a brush, as they cannot then turn round and lick themselves or rub as they would in the field.

The feet should also be examined, lest they should get too long and thereby weaken the pasterns, which is easily remedied by the removal of a portion of the toe with a small saw.

As a general principle, cows should be milked twice a day, and the times of milking should be invariable all the year round,

viz., at six in the morning and six in the evening. If after calving, in the early state of milk, it should be found that the bag becomes too full from extreme heat or other cause, it will be advisable to reduce the bag in the middle of the day, in which case eight o'clock in the evening will be early enough for the last milking; but some judgment is requisite in putting this into practice, as too great eagerness to relieve the bag may have an injurious effect, by weakening its power of retention. Before and during the time of milking, the cow should have some good hay, chaff, or meal. This is beneficial in two ways;—first, it is a wholesome stay to the stomach; secondly, it engrosses the attention of the animal and quiets it during the operation.

The hands should be dry and clean; wet hands chap the teats in cold weather, and want of cleanliness produces warts. Take great care that the last of the milk is withdrawn, as one pint of this is richer for the production of butter than two quarts of milk first drawn off. This point is of paramount importance, as, independently of the quality thus produced, imperfect milking will dry the cow much earlier than if properly milked, and tend to decrease the quantity. Milk as quickly as possible, and never leave the cow during the operation: an active milker may milk five* cows an hour; therefore, with a dairy of ten or twelve cows, two persons should be employed, and so in proportion, or regularity will be interfered with. Six weeks prior to the time of calving, commence to dry the cow by milking once a day for three or four days, which will decrease the quantity; then cease milking for three days, taking care that the bag does not get overfilled by the cessation, which must be very carefully observed in hot weather; after this the judgment must be exercised as to any future milkings, which, if possible, should cease altogether one month before calving. In all cases thoroughly cleanse the bag, as, should any milk be left, disease may be originated by the remaining secretion, which will be very injurious at the next time of calving. A few days prior to calving, should the bag be found much distended, it should be thoroughly relieved. This system I have pursued for many years, having a hundred calves annually without the loss of a single cow.

Whatever may be the cause of restlessness or irritability of

*The best dairyman in our state requires his men to milk, each, twelve cows an hour.

the cow during milking, gentleness is the only treatment that should be allowed,—violence, or even harshness, never. There are many causes after recent calving that may produce inquietude, but no other remedy will be effectual. A young animal never forgets ill treatment, and a recurrence of similar circumstances will remind the cow of former punishment.

Previously to entering upon the subject of pregnant cows, a few observations on the bull may prove of great advantage.

There is a notion very prevalent, that frequent serving of the cow will insure a calf; experience has proved this to be erroneous. Once is quite sufficient; but where the bull is of a larger kind than the cow, the latter should have the advantage of rising ground. On returning home the cow should be milked and tied up till quiet. Cattle taken to the bull are less subject to barrenness than those running with the bull.

For milking cows it is always advisable to have a bull with two or three years' advantage of age, as the stock is not then produced too large, which would probably injure the womb and produce barrenness. The heifer should not be taken to the bull younger than from eighteen to twenty-one months; and, after calving, six weeks should elapse before the cow is again served.

When the cow is heavy in calf, that is, when within about three months of the time of calving, considerable judgment is required as to her condition. At this time she should have plenty of exercise, should walk a considerable distance to and from pasture, and when there should have to get her own living, or rather to work for her own living, if it may be so expressed, by the feed's not being over-abundant. Where exercise cannot be obtained, or where the cow is kept housed, or in a very small pasture, she must be prevented from getting too fresh by a diminution of the feeding qualities of her food.

If the cow continues to give her full quantity of milk up to a late period, there will be no danger at the time of calving; but if she dries up too soon, she will get too fresh to be healthy, and means must be taken to diminish her condition, either by increasing her exercise or diminishing her food. A lean cow can never come to harm by calving, but a fat one labors much more, and is liable to break the blood-vessels, or to induce prolapsus, frequently resulting in death.

With heifers with their second calf care should be taken that the system be not overtaxed, and they should therefore be allowed to go dry sooner than older cows.

At no period of a cow's being with calf should any putrid or offensive matter—such as pig-tubs containing all manner of decayed refuse, or horse-flesh hanging up for dogs, or dead animals in ditches and ponds—be within her scent, for so delicate is the constitution of a cow in this state that the mere smell of offensive effluvia is sufficient to make her slip her calf; the same result may be produced by her running in the same pasture with a cow which has recently slipped her calf. As the cow advances in calf she should not be allowed to pasture with strange cattle, as they would be likely to fight, or push each other about, and injury to herself and the calf might ensue: perfect quietness in this state cannot be too much recommended.

When the period of calving arrives, the cow should be taken in and well bedded forward, giving an easy declivity to the hinder parts; she should be disturbed as little as possible, but carefully watched. Every opportunity should be given to nature to act spontaneously, but if much difficulty appears, the assistance of a veterinary surgeon should be obtained at once.

When this is rendered unnecessary by an easy labor, care should be taken to remove the caul or bladder covering the calf's head as soon as possible, to enable it to breathe; and immediately after the birth compel the cow to rise, as this action restores the overstrained parts to their proper position. Then subdue the tendency to inflammation by immediately withdrawing the milk.

In some places an erroneous custom prevails, of giving the cow her own milk to drink just after calving, but this is an exploded and almost superstitious custom, which should never be followed.

If the cow appears strong after calving, avoid giving her drenches, which produce disgust and do no good.

If medicine appears necessary, let it be given under the direction of the veterinary surgeon.

In all the numerous cases that have fallen under my management, I have never had one occasion to give a single drench. My system is to give the cow warm bran-mash with plenty of

chilled water, not too warm, which treatment has always proved successful.

If the cow, after calving, should not milk down well, the udder should be fomented with warm water.

In a small practical work of this nature it would be useless to enter at length upon the diseases of cows; a few hints will be much better than a dry dissertation. No information that could be here imparted would be of any use in the absence of experience. It will be only necessary, therefore, to give some account of the symptoms that usually indicate disease either in existence or in embryo.

The first symptom usually is the shrinking of the milk; the second symptom is a rough and staring appearance of the coat, hollowness of the eyes, and a want of moisture at the nose. What is called a chill is easily discovered by pressing with the hand on the back anywhere behind the shoulders, which act will cause the cow to shrink if she is not in good health.

Nothing but knowledge and experience will justify the attempt to physic the cow without the advice of the veterinary surgeon; and it must be borne in mind that the object of this paper is to instruct in the management of milch cows alone, and not to enter upon the management and treatment of the various other classes of cows which are kept for a very different purpose than the production of milk and butter.

In continuation of this subject we give a few paragraphs from Mr. James Lawrence's paper on

GUERNSEYS.

The island from which these cattle take their name forms one of a group of four,—Jersey, Guernsey, Alderney, and Sark,—situated close together, and not far from the northern coast of France, forming what is known as the Channel Islands Group.

Originally all animals of these islands were called Alderneys, although that island is only one fifteenth the size of Jersey, and one sixth the size of Guernsey. They are now classified according to the island on which they are bred.

The size and population of the islands are as follows: Jersey, 62 square miles, 39,000 acres, population 60,000; Guernsey, 24 square miles, 15,000 acres, population 25,000; Alderney, 4 square miles, 2,500 acres, population 4,000.

The farms as a rule are small, without fences or walls, and owned by the occupiers. The average size of a herd is from four to six cows. Inasmuch as there are no fences, the plan has been adopted of tethering the cows with a chain and stake, giving them a range of twelve feet. They are moved five times a day, thereby insuring ample and sweet pasturage. In this way a small farm keeps a large proportion of cattle to its manifest increase of fertility. To this custom, and to the fact that the women of the family milk and feed them, is also owing the great docility always noticeable in imported cattle.

Of the three breeds of cattle, Jersey, Guernsey, and Alderney, the Guernsey is by far the heaviest and most profitable, alike at the pail and for the butcher, fat beasts reaching frequently a dead weight of 1,000 pounds. The breeds are kept entirely distinct, all importation of live animals into either island, from any source whatever, being strictly forbidden by laws passed in the last century.

In this way the breeds have received an individual character, as remarkable for its general excellence as for its special characteristic,—the giving of rich milk containing a high percentage of butter. To this end have the native breeders directed all their energies; and so successful have they been that there is now scarcely a dissentient voice as to the superiority of the Channel Island cattle at the churn.

Externally, the Guernsey is a fine-looking, good-sized animal, averaging about 925 pounds; of full, deep carcass, small bones and horns, and mild, benignant head. In color she is yellow, lemon fawn, orange fawn, or red, and frequently shading into a peculiar brindle. Her hair is moderately fine, and her skin peculiarly orange in color, signifying thereby the tendency to secretion of fat, and consequent enrichment of milk. This deep color is especially noticeable around the eyes, on the inside of the ears, upon the udder, and at the point of the tail. The muzzle and hoofs are yellow or black, breeding from bulls of either type being practised indiscriminately on the island.

Internally, the Guernsey cow is of good appetite, and thrifty, eating all that is offered her, and flourishing on it.

The usual mode of feeding on the island is as follows: The calves are taken from the dam as soon as possible after calving, and for the first three weeks receive sweet milk. For the next eight months they receive sour milk with roots and hay, or grass alone, depending upon the season of the year. No cake or grain is given. After calving, the cows receive bran mashes for a few days, until the flow of milk is well established, when they settle down to their regular diet of hay, roots, and chaff in winter, and green food in summer. The principal root grown is the parsnip, which on good land produces about twenty tons per acre.

The butter produced from cows fed in this simple way is of a peculiarly deep orange color. That the flavor is good is best shown by the price commanded. In 1881 Guernsey butter was selling on the Island of Jersey for 2d. per pound more than Jersey butter. During the latter part of May, 1883, my own herd of twenty was averaging ten pounds each per week. Their food at that time was pasturage and two quarts of grain to each cow per day. Nothing else was given. The highest quantity per cow was eleven pounds. The grain ration was composed of one quart of corn meal and one quart of bruised oats. That they would have done much better on higher feed is unquestionable, but as my cows are fed for profit, and not for records, I did not think it wise to increase the feed. The amount of milk required was eighteen and one half pounds to a pound of butter.

The *average* yield of milk, as ascertained by comparing a number of herds, is about 5,400 pounds a year, although of course many cows run up to 7,000 pounds and more. The average amount of milk required for a pound of butter is, in winter, eighteen pounds, and in summer, twenty-two pounds. In my own herd of twenty, the average yield has been, for the past six years, about 5,100 pounds, the average amount of milk required for a pound of butter being as stated above.

To sum up, the Guernsey breed possesses the qualities of size, docility, hardiness, aptitude to fatten, and unequalled excellence for the production of butter. Crossed with the native stock of

the country, they produce an animal unsurpassed in the qualities necessary for the dairy and for the average farmer.

Though not exactly in the line of the subject thus far, we copy from Mr. Fowler the following on dairy management:

The dairy-house should be built on slightly-elevated ground, and on a dry spot, sheltered as much as possible from the south, north, and east; it should be sunk at least a foot in the earth for the sake of coolness.

The floor should be of bricks or tiles, on a descent toward the drain, which should have a plug, so that spring water may be retained on the floor for three or four hours during the day, in the heat of summer. The plugging of the drain when its use is not required will also have the effect of preventing any effluvium from rising through it, which might originate at its outlet from decayed vegetable or other matter.

The benches, which should be kept a few inches from the wall, to allow of free ventilation and to prevent insects from falling into the pans, may be of stone or slate, the latter material being preferable.

The windows, which should be so placed as to allow of a free current of air passing through the building, should be of perforated zinc, with shutters to close in the winter; and exteriorly to every window where the sun can fall at any time of the day there should be placed a kind of Venetian blind, to keep the rays from falling through the zinc.

Never allow the dairy to be used for any other purpose than that for which it was originally intended: nothing but milk, cream, and butter should at any time be permitted to be placed there. To use it as a pantry, or to keep beer in, is to insure tainted butter. The rays of the sun should be carefully kept from falling on any part of the cream, either in process of formation, or when skimmed off ready for churning.

The dairy utensils consist of the churn, sized according to the number of cattle and frequency of churning; pans for holding the milk, containing from eight to ten quarts, and as shal-

low as possible; a deep pan to hold the cream during accumulation; neat butter-prints, of white wood; ivory butter-slice; fine linen cloths, to cover the butter; a marble slab, to deposit the butter on; a small ladder, to lie across the milking-pans, to support the strainer; the strainer itself, consisting of a sieve-hoop about seven inches deep, with a band to fit over it to keep the straining-cloth closely on; milking-cans, of strong block tin, as being more easily kept sweet than wooden buckets; and good flat wicker baskets to carry the butter.

The milk-pans I recommend to be made of glass, which is a non-conductor of lightning, and can be kept sweet and clean by merely wiping with wash-leather, while scalding will scarcely be sufficient for a porous material. The cream-pan should also be of glass.

The most scrupulous cleanliness, in every particular, is absolutely indispensable.

As soon as ever the milk is taken from the cow, strain it carefully through the sieve into the pans before it gets cool; after which it should not be disturbed till skimmed, and care should be taken not to agitate the milk before it is deposited in the pans to set; all milk required for use must therefore be taken before putting in the pans.

As equable temperature is advantageous to the speedy production of the cream, in hot weather the floor of the dairy should be kept moist, to produce coolness by evaporation; and in winter a small stove will be of benefit if smoke and smell be avoided in its use.

To produce the most delicate butter, where economy is not an object, the first rising of the cream (about twelve hours after the milk has been panned) should be taken; but for ordinary purposes the milk should stand twenty-four hours in summer and forty-eight in winter. The cream, while accumulating, should be stirred night and morning, which will air it and keep it sweet to churn once or twice a week,—that is, once a week in the cold and cool months, and twice during the warm months, June, July, August, and September.

Be careful to keep all tin vessels well-tinned, so that no rust of iron shall come in contact with the milk; and look well to the earrings of the pail handles, that grease and dirt may not

accumulate there. Be sure also that your strainer and all other cloths are kept well scalded and cleansed; in fact, too much stress cannot be laid on the word *cleanliness*.

The process of churning will be much promoted in winter by warming the churn with hot water previous to putting the cream in; and in summer, cold spring water put in the churn with the cream will make your butter firmer. The churn should not be above two thirds filled for churning.

It will be noticed that we omit all mention of the Jerseys, though they constitute the largest class of the Channel Islands cattle. They require a chapter by themselves.

OUR PRODUCTIONS AND POSSESSIONS.

BY THE SECRETARY, BEFORE THE STATE GRANGE.

It used to be said that a certain clergyman of the old school, who dwelt almost exclusively upon the doctrines of his church, on one occasion, finding it necessary to present statistics and detail of statement, apologized to his hearers after this manner: "You know, my friends," said he, "that I am not in the habit of giving you facts in this sacred desk, but to-day I propose to go out of my usual line of discourse and give you a sermon of solid facts."

Now, without pleading guilty to the honest confession of the parson, I will accept his proposition without his apology, and give you such an array of facts and figures as will forever exempt me from appearing before you on such cordial invitation as I have always received from your accomplished secretary.

We have in our little triangular state an area of 9,305 square miles, including wild lands, mountains, public waters, and territory unavailable for farm purposes. This gives us almost 6,000,000 of acres, or, more definitely,—for you will remember I am to deal in facts,—5,955,200 acres. Including one half of the Piscataqua river on the east, all of the Connecticut on the west, with the lakes and ponds and streams within our boundaries, we have 192,000 acres of water. But if these water acres are capable of producing as valuable products as an equal area of improved land, we are at liberty to take them into our inventory on the same basis.

This broad area has an aggregate value, including its improvements, its dwellings, and other buildings, as valued for taxation, of $122,783,124. If to this we add the personal inventory,

we have a total of $164,753,181. But this is a taxation value, not one of an intrinsic nature. The true value of the real estate in the commonwealth—equalizing the country and the city valuation at $30 per acre, including buildings—would give us the sum of $178,556,000, to which we may add, as personal property, twice the amount taxed, and we have as our civil inheritance the value of $262,700,000, or more than $750 for each man, woman, and child in the state.

But I shall be obliged here to accept the parson's apology, for the time, and admit that the value is not a fact, unquestionable, but largely hypothetical. It may be true, but neither town assessors nor census marshals have made such gratifying returns.

The census of 1880 records a population, wanting but nine units, of 347,000; number of families, 80,286; dwellings, 68,381. This gives to each person 16.5 acres of land; to each square mile a population of 38.5. Total number of farms, by census of 1880, is 32,181, the largest number ever returned in any census, showing a renewed tendency to agricultural pursuits. Of these, 29,566 are occupied by the owners; 1,237 are rented for money; and 1,378 are rented on shares of income or products. Of these farms, 104 contain, each, more than 1,000 acres. It will be seen that but few men in our state are immense landowners. Now and then a man owns several farms. I have in mind a gentleman who holds a clear title to twenty-six farms, and has a fee-simple in 80,000 acres of land. And I would say here, that he has made a standing offer to give the use of a farm to any industrious and prudent young man for a series of years, on payment of taxes and repairs.

We have referred to the population of the state, and it is very proper here to note the employments of the people. Allowing all under ten years of age to be exempt from labor, we have 286,188 persons, who, from their age, unless exempt by some special cause, should be engaged a portion of the time in productive labor. Of these, more than half are females—usually the most industrious class. Scarcely one half of these 286,000 are assigned to any industrial pursuits. Others labor, but do not claim, perhaps do not merit, compensation above their support for services rendered. The number of men

engaged in agriculture is 44,490; of women, 191. Here is evidently a deficiency in our census, for it regards as nonentities the 30,000 or more farmers' wives, who work harder, plan better, and save more money than the farmers themselves. I say 30,000,—to which I might add 15,000 more, the daughters of farmers,—who still cling to the old farm-house and aid in the wearisome drudgery of the kitchen and the dairy.

As Secretary of the Board of Agriculture, I protest against making mere ciphers of 45,000 women and girls by our government, and I call on the bachelor Secretary of the State Grange, and more earnestly on the two bachelor members of the Board of Agriculture, to do all in their power to right this great wrong. But if these ladies be ciphers, they stand on the right hand of significant figures and increase their importance tenfold.

Those engaged in professional and clerical pursuits are 16,158 men and 12,048 women; in trade and transportation, 11,208 men and only 527 women. In my earlier day it was the reverse: one half the young ladies, at least, were engaged in the transporting business, though of a more gentle character! How is it now? Ask your bachelor friend from Dunbarton, and my single-blessedness comrades from Belmont and Durham! As bondholders, the ladies very properly nearly equal the men, being 1,353 to 1,586.

In manufactures, mechanism, and mining, the men number 40,675, and the women 17,362. The number of men employed in productive industry is put down at 112,300, while only 30,119 women are included. More than 80,000 women in our state are actually doing nothing, or else the census is a fraud. The increase in the last ten years of those employed in productive labor is 19 per cent.

Let us now look to the amount of farm productions reported. They exceed in value annually $13,000,000. The hay product, census year, was given as 583,069 tons, a much smaller amount than is produced in an average year.

Hops,	23,955 pounds
Orchard products,	$1,000,000
Potatoes, which are yearly diminishing,	3,358,828 bushels
Wool,	1,060,589 pounds

Milk sold,	5,739,128 gallons
Butter,	7,247,272 pounds
Cheese,	807,076 pounds
More than	$2,000,000 from the dairy
Barley,	77,877 bushels; loss, 30,000 bushels
Buckwheat,	94,090 bushels; loss, 6,000 bushels
Corn,	1,350,288 bushels; gain, 75,000 bushels
Oats,	1,017,620 bushels; gain, 75,000 bushels
Rye,	34,638 bushels; loss, 13,000 bushels
Wheat,	169,316 bushels; loss, 25,000 bushels
Pease, beans, garden-truck, and tobacco, another	$1,000,000

In regard to domestic animals, we find credited to us 46,773 horses, an increase of 20 per cent.; working oxen, 29,152, a decrease of 28 per cent. [I desire here to raise the question as to the policy of employing horses, rather than oxen, on our farms. I cannot discuss it now, but believe it to be a great mistake.] Cows, 90,564, an increase, but a very small one. We ought in justice to our farmers to double the number of our milch cows. The product is over $2,000,000, besides the milk fed to animals. Other cattle, 112,689, 23 per cent. increase; sheep, 211,825, decrease of 10 per cent.; swine, 53,436, 6 per cent. increase.

Poultry is not recognized in census returns, but the amount annually produced in the state is near a million dollars in value, while the eggs marketed will exceed that sum.

Dogs, though taxed, are not valued as are other animals; but from the demonstrations made for them at cattle fairs, we might infer that they hold a front rank.

The quarries of granite and soapstone number thirty-nine. Capital, $128,000; product per year, $303,000.

The amount of gold mined is 532 oz., value $11,000; silver 12,375 oz., value $16,000.

Paper made, 5,480 tons; value $1,731,170.

Number of steamboats employed on the ocean,	25
Tonnage,	55,000
Value,	$126,000
Passengers carried,	55,000
Earnings,	$55,000
Wages paid,	$20,000

We have of

Blind persons,	412
Insane,	1,000
Idiotic,	703
Deaf mutes,	221
Paupers,	2,037
Prisoners,	273

The water products amount to $176,841, to say nothing of the results of twenty years' work in stocking our ponds and streams. About 400 persons are employed in coast-fishing, and something like $125,000 is invested in the business.

There are other items entering into the material prosperity of the state. We ought not to pass over, even at an agricultural gathering, that great interest on which our rural prosperity depends,—manufactures. There are within our limits 3,181 manufactories, with a capital of $51,000,000, employing 29,356 men and 16,184 women. Cost of labor, $14,814,793; cost of material, $43,552,462; value of products, $73,978,028.

We have never claimed preëminence in garden products, but we have localities on the margins of our rapid rivers, and in proximity to our busy cities and manufacturing towns, that add bountifully to the farmer's income. We have in good seasons made 2,000,000 pounds of maple sugar, and nearly 1,000,000 pounds of honey. We do but little in the growing of hemp and flax, but have built up an immense business in soapstone and granite quarrying, and in making bricks and gathering ice, and have mown down the forests with a ruthless hand.

But I can dwell no longer on the material prosperity of our state. It has been a good state to be born in, and is yet a good state to live in. I must not, however, neglect to recall some of its agencies for rural improvement. We have the credit of holding the first agricultural fair in the United States, which occurred more than 160 years ago. Sixty years ago agricultural societies were established in each county, and received aid from the state. These have lived and died, as have their successors. Our state society has had an existence of thirty years, and is looking forward to its golden anniversary. Within ten years the Patrons of Husbandry, under whose auspices we are gath

ered to-day, have opened their halls and spread their harvest feasts in more than one third of the towns in the state, and are adding a charm to rural life.

Sixty-two years ago we had a board of agriculture, the first, or near the first, in the Union. To-day its successor, now in its second decade, is endeavoring to make its influence felt at home and abroad. Added to other agencies, we have a college of agriculture, free from debt, but limited in its means, which is quietly and persistently making its impress on the agriculture of the state.

Now, in closing, I desire to say,—though nature has not been lavish in the bestowal of a fertile soil, though our plains produce only by the application of labor and fertilizing material, and our hills yield reluctantly their annual harvests, though our rural population is reduced from year to year, and farms once productive have been abandoned to pasturage and forestry,—we have not retrograded in agricultural and business activity, nor in our general industrial interests. Though we find much to discourage us in the culture of our stubborn fields, in the severity of our winters, the frosts of spring and autumn, and the droughts or floods of summer; though we are subject to heavy taxes, and oftentimes dispose of the increase of our flocks and the products of our soil at scarcely compensating prices; though we see with regret, and even sorrow, our sons and daughters abandon the farm for city life, or a home in the great West,—we have yet much to encourage us in the general prosperity of the state; in the upspringing of cities by our rapid water-falls; in the increase of manufacturing interests, and the consequent increased demand for the surplus of our fields, our pastures, and our forest lands.

We take pride in the intelligence of our population, the higher elevation of our educational institutions, and in the moral integrity and the unswerving patriotism of our citizens.

THE GRASSHOPPER.

BY THE SECRETARY.

Our state has generally been little troubled with noxious insects. We have, in common with other states, the potato beetle and the curculio, formerly had the Hessian fly, and occasionally the canker-worm, and the ordinary bugs, and grubs, and millers, and moths. But it is only in a long course of years that a destructive visit is made by the grasshopper, or its near kin, the locust. Fifty years ago, old people tell us, great destruction of crops was caused by the grasshoppers, which came in such multitudes as to destroy the harvests, eat clothing, and even ruin the small limbs of fruit-trees.

Within a period of ten years a peculiar species of grasshopper has visited special localities in the state, causing the farmer great injury. They have been most abundant on the intervals between Concord and Franklin, a distance of about ten miles. They have destroyed a large portion of the grass year by year, seriously injured corn and other cereals, and gorged themselves with the vegetable growth of the garden.

The past season they have been more destructive than at any former period, and on some farms have reduced the hay crop more than one half, besides destroying much other vegetable growth.

They make their annual appearance early in June, and for a time, though they are very numerous, do not excite alarm: but a few weeks' growth makes them a formidable enemy, defying the efforts of the husbandman to destroy them, or check their ravages.

Six or eight weeks are required to give them maturity, at which time they deposit their eggs in sandy or barren places, and soon take their flight, die, and are seen no more.

The past season, Mr. C. V. Riley, the entomologist of the government, made visits to the locality, and thoroughly examined the insects. His report of them has not been made at the time of the printing of this volume.

Though they differ somewhat from the destructive locust of the West *(Spretus)*, they are not very unlike that enemy of the farmer. It may be that they are the same species, but modified somewhat in form by the locality in which they are bred.

On the recommendation of Prof. Riley, kerosene was freely used to destroy them. Whenever this was sprinkled on them, they immediately perished. But it is no easy labor to apply kerosene without injuring the vegetable growth. The most effectual method employed was by the aid of a long tin or sheet-iron scoop, with back and ends, but a low front, charged with kerosene mixed with milk. This was drawn by horse-power, and gathered up the young insects by the bushel. They died as soon as they fell into the scoop or were spattered with the mixture. In five hours, on one farm, one person gathered thirty-four bushels on fourteen acres. Though hundreds of bushels were destroyed, they did not appear to be reduced in number, nor in the power of destruction.

They do not thrive in wet weather, and studiously avoid wet, low places.

A law was passed at the last session, granting a bounty of one dollar a bushel for all that are taken in the months of June and July. As they are small during most of these months, the inducement is not very encouraging: but as the farmer will generally make the effort to destroy them, the bounty will be an aid.

The report of the Entomological Commission, of which Prof. Riley is a member, contains an extended account of the habits and history of the locusts, differing somewhat from our pest, which we copy freely:

DESTRUCTIVE POWER OF LOCUSTS.

No one who has not witnessed the ravaging power of locusts can fully conceive of or appreciate it. The organization and habit of the typical locust admirably fit it for ravenous work. Muscular, gregarious, with powerful jaws and ample digestive

and reproductive systems, strong of wing, and assisted in flight by numerous air-sacs that buoy,—all these traits conspire to make it the terrible engine of destruction which history shows it to have been, under conditions favorable to its excessive multiplication. Insignificant individually, but mighty collectively, locusts fall upon a country like a plague or a blight. The farmer plows and plants. He cultivates in hope, watching his growing grain, in graceful, wave-like motion, wafted to and fro by the warm summer winds. The green begins to golden; the harvest is at hand. Joy lightens his labor as the fruit of past toil is about to be realized. The day breaks with a smiling sun, that sends his ripening rays through laden orchards and promising fields. Kine and stock of every sort are sleek with plenty, and all the earth seems glad. The day grows. Suddenly the sun's face is darkened, and clouds obscure the sky. The joy of the morn gives way to ominous fear. The day closes, and ravenous locust swarms have fallen upon the land. The morrow comes, and, ah! what a change it brings! The fertile land of promise and plenty has become a desolate waste, and the sun, even at his brightest, shines sadly through an atmosphere alive with myriads of glittering insects. The suffering in the country invaded in 1874, and the dreadful desolation the following spring, are sufficiently fresh in the minds of Western farmers.

Falling upon a cornfield, the insects convert, in a few hours, the green and promising acres into a desolate stretch of bare, spindling stalks and stubs. "Covering each hill by hundreds; scrambling from row to row like a lot of young, famished pigs let out to their trough; insignificant individually, but mighty collectively, they sweep clean a field quicker than would a whole herd of hungry steers. Imagine hundreds of square miles covered with such a ravenous horde, and one can get some realization of the picture presented in many parts of the country west of the Mississippi during years of locust invasion.

"Their flight may be likened to an immense snow-storm, extending from the ground to a height at which our visual organs perceive them only as minute, darting scintillations, leaving the imagination to picture them indefinite distances beyond. 'When on the highest peaks of the Snowy Range, fourteen or fifteen

thousand feet above the sea, I have seen them filling the air as much higher as they could be distinguished with a good field-glass.' It is a vast cloud of animated specks, glittering against the sun. On the horizon they often appear as a dust tornado, riding upon the wind like an ominous hail-storm, eddying and whirling about like the wild, dead leaves in an autumn storm, and finally sweeping up to and past you with a power that is irresistible. They move mainly with the wind, and when there is no wind they whirl about in the air like swarming bees. If a passing swarm suddenly meets with a change in the atmosphere, 'such as the approach of a thunder-storm or gale of wind, they come down precipitately, seeming to fold their wings, and fall by the force of gravity, thousands being killed by the fall, if it is upon stone or other hard surface.'"

An idea of the vast numbers that will sometimes descend to the ground may be formed by the following occurrence, related to us by an intelligent and reliable eye-witness, Col. H. McAllister, of Colorado Springs, Col. In 1875, early in August, a swarm suddenly came down at that place. The insects came with the wind, and alighted in a rain. The ground was literally covered two and three inches deep, and glittered "as a new dollar" with the active multitude. In rising the next day by a common impulse, their wings would get entangled, and they would drop to the ground again in a matted mass. "In alighting, they circle in myriads about you, beating against everything animate or inanimate, driving into open doors and windows, heaping about your feet and around your buildings, their jaws constantly at work, biting and testing all things in seeking what they can devour. In the midst of the incessant buzz and noise which such a flight produces, in face of the unavoidable destruction everywhere going on, one is bewildered and awed at the collective power of the ravaging host, which calls to mind so forcibly the plagues of Egypt.

"The noise their myriad jaws make when engaged in their work of destruction can be realized by any one who has 'fought' a prairie fire, or heard the flames passing along before a brisk wind—the low crackling and rasping: the general effect of the two sounds is very much the same. Southey, in his Thalaba, most graphically pictures this noise produced by the flight and approach of locusts:

Onward they come, a dark, continuous cloud
Of congregated myriads numberless,
The rushing of whose wings was as the sound
Of a broad river, headlong in its course
Plunged from a mountain summit, or the roar
Of a wild ocean in the autumn storm,
Shattering its billows on a shore of rocks!

RATE AT WHICH LOCUST SWARMS MOVE.

The rate of migration of the winged insects will depend entirely on circumstances. The history of the past four years shows conclusively that the rate of progress of invading swarms from the permanent breeding-places will average about twenty miles a day. It is, however, exceedingly irregular, and greatly dependent on the velocity of the wind. Bad weather may impede, or adverse winds divert, flight.

"One noticeable feature of the invasions is the greater rapidity with which the insects spread in the earlier part of the season, while in fullest vigor, and the reduction in the average rate of progress the farther east and south they extend. The length of their stay depends much upon circumstances. Early in the summer, when they first begin to pour down on the more fertile country, they seldom remain more than two or three days, whereas later in the season they stay much longer. In speaking of the advent and departure of these insects I use relative language only. The first comers, when—after having devoured everything palatable—they take wing away, almost always leave a scattering rear guard behind, and are generally followed by new swarms; and a country once visited presents for weeks the spectacle of the insects gradually rising in the air between the hours of 9 or 10 A. M. and 3 P. M., and being carried away by the wind, while others are constantly dropping."

In short, the rate of spread is greatest during the first ten or fifteen days of their winged existence, or before the females become occupied with egg-laying. The invading insects are then passing the extensive plains and thinly-settled regions of the North-west, where there is little inducement for them to halt, and the rate at such times, with strong and favorable wind, may reach a maximum of from two to three hundred miles a day.

Extended flight does not take place till four or five days after the first insects become winged. For the first two or three days the newly-winged individuals mingle with the larvæ and pupæ, eating ravenously, and making short flights of a few yards or rods, as if to try their wings, recalling fully the habit of native, non-migratory species. Then for a while they rise, one by one, higher in the air, and float along with the wind, and finally, when weather and wind are favorable, all that are strong and mature enough rise as with a common impulse during the warmer morning hours, and move off vigorously in one direction, till they are soon out of sight. "They begin to rise when the dew has evaporated, and generally descend again toward evening. A swarm passing over a country yet infested with the mature insects constantly receives accretions from these, and is consequently always more dense in the afternoon than in the forenoon. In rising, the insects generally face the wind, and it is doubtful if they could ascend to any great height without doing so."

DIRECTION OF INVADING SWARMS.

While there may be, during an invasion, local flights in all possible directions (except, perhaps, due west), the general movement east of the mountains is conspicuously toward the south and south-east. The more local and irregular flights are generally made for food, but the more extended, southward movements are in obedience to natural laws. West of the main Rocky Mountain range the rule of flight appears to be from the higher plains and plateaus, where the insect normally breeds, to the lower and more fertile valleys; and the greater irregularity of the prevailing winds and more broken nature of the country preclude the same regularity in directions of flight that, on the whole, prevails east of the range.

TIME OF APPEARANCE OF INVADING SWARMS.

"In endeavoring to deduce general conclusions respecting the time of year that the 1874 swarms reached different parts of the country, great difficulty was experienced in sifting those accounts which referred to the progeny of the 1873 invasion, and those which hatched within the insect's native range, and came from the extreme North-west. The same was true of the fresh 1876 swarms, and those which hatched in Minnesota."

As a rule, the insects which hatch in the temporary region acquire wings, and leave before the fresh swarms from the mountain region appear. In the more northern regions, as in Minnesota and Manitoba westward, the insects hatched on the ground acquire wings the latter part of June and in July. The period is earlier as we go south, until in southern Texas they are able to fly in April. The time of appearance of invading swarms from the permanent region is in inverse ratio, *i. e.*, earlier to the north, and later to the south. Thus, while on the confines of the permanent region it is almost impossible to distinguish between the insects which hatch there and the fresh swarms from the North-west, the difference becomes more and more marked toward the south and east.

GENERAL HABITS AT NIGHT.

Regarding the general habits of the species at night, a glance at the experience obtained in answer to our circulars is sufficient to show that it differs widely, and is often contradictory. This is not surprising, as so much in the habits and ways of our locust depends on conditions of the weather, season, etc. We have had an extensive experience both with the unfledged and full-fledged insects, and the result of it is, that as a rule the young insects are quiet at night, either hiding under some shelter upon the ground, or roosting away from the ground. The former is more apt to be the case in cold, the latter in wet, weather. In cool weather even the mature insects do not feed at night, but when the weather is warm and dry these are often as ravenous during the night as during the day. Gerstaecker remarks of the European *migratoria*, that it feeds mostat night.

As the insects advance in age the roosting habit becomes greater, and for a few days after getting wings the mature insects delight to gather away from the ground, especially on trees.

SEXUAL HABITS.

There are various questions coming under this head that have a scientific bearing, but do not materially concern the farmer. The love-season may be said to commence just as soon as all the parts of the full-winged individuals have become hardened and perfected, and to endure till near death. Nevertheless, the

most active and ardent period occurs during the first two or three weeks after maturity, and it is during this period also that the migrating instinct is most developed. Every one who has closely observed these insects is aware that they are salacious in habit.

WHERE THE EGGS ARE LAID.

"The eggs may be laid in almost any kind of soil, but by preference they are laid in bare, sandy places, especially on high, dry ground, which is tolerably compact, and not loose. It is often stated that they are not laid in meadows and pastures, and that hard road-tracks are preferred. In truth, however, meadows and pastures, where the grass is closely grazed, are much used for ovipositing by the female, while on well-travelled roads she seldom gets time to fulfil the act without being disturbed. Thus a well-travelled road may present the appearance of being perfectly honey-combed with holes, when an examination will show that most of them are unfinished, and contain no eggs, whereas a field covered with grass-stubble may show no signs of such holes, and yet abound with eggs." In fact, wherever holes are noticed it may generally be taken for granted that they contain no eggs, for the mother covers well the hole when she has time properly to complete her task.

"Furthermore, the insects are more readily noticed at their work along roads and road-sides than in fields, a fact which has also had something to do in forming the popular impression. Newly plowed land is not liked; it presents too loose a surface; but newly broken sward is often filled with eggs. Moist or wet ground is generally avoided for the purpose under consideration."

We have noticed that in the permanent breeding-region, wherever the vegetation is scant the females show a decided preference for the shaded base of shrubby plants, among the roots of which they like to place their eggs; whereas in the temporary region, where the vegetation is generally so much ranker, exposed situations, or those comparatively bare of vegetation, are preferred. The experience of 1876 proved very conclusively, also, that they are instinctively guided toward cultivated fields, where the young will find good pasturage, for the eggs were noticeably thickest and hatched most numerously in 1877 in cultivated areas. In the Cypress Hills region of British Amer-

ica, as Mr. J. G. Kittson informs us, the high lands and protected slopes of the hills are preferred. The soil of the mountain region, where the insects permanently breed, is mostly of a compact, scantily covered, gravelly nature, and the notion that they lay most in pure sand is an erroneous one.

Sandy soil that is compact, especially when having a south or east exposure, is much chosen, but in loose and shifting sand the eggs would perish. In 1876 it was generally remarked that the insects were more indifferent than usual in ovipositing, and that eggs were much more frequently laid in low and even wet land than in former years..

The mass seldom reaches more than an inch below the surface, except where some vegetable root has been followed down and devoured, and the insect leaves her eggs before emerging. In this way the mass is sometimes placed a foot below the surface.

DOES THE FEMALE LAY MORE THAN ONE EGG-MASS?

This is a question often asked, but which the average farmer has no means of definitely answering. "It is the rule with insects, particularly with the large number of injurious species belonging to the Lepidoptera, that the eggs in the ovaries develop almost simultaneously, and that when oviposition once commences it is continued uninterruptedly until the supply of eggs is exhausted. Yet there are many notable exceptions to the rule among injurious species, as in the cases of the common plum curculio and the Colorado potato beetle, which oviposit at stated or irregular intervals during several weeks, or even months. The Rocky Mountain locust belongs to this last category, and the most casual examination of the ovaries in a female, taken in the act of ovipositing, will show that, besides the batch of fully-formed eggs then and there being laid, there are other sets, diminishing in size, which are to be laid at future periods. This, I repeat, can be determined by any one who will take the trouble carefully to examine a few females when laying. But just how often or how many eggs each one lays is more difficult to determine. With *spretus* I have been able to make comparatively few experiments; but on three different occasions I obtained two pods from single females, laid at intervals of eighteen, twenty-one, and twenty-six days, respectively.

THE HATCHING PROCESS.

The rigid shell of the bird's egg is easily cracked by the beak of its tenant; the hatching caterpillar curled within its egg-shell has room enough to move its jaws and eat its way out. The egg-coverings of many insects are so delicate and frail that the mere swelling of the embryon affords means of escape; those of others are so constructed that a door flies open, or a lid lifts by a spring, whenever pressure is brought to bear. In some two halves open, as in the shell of a muscle, while in a host of others the embryon is furnished with a special structure called the egg-burster, the office of which is to cut or rupture the shell, and thus afford means of escape. But our young locust is deprived of all such contrivances, and must have another mode of exit from its tough and sub-elastic prison. Nature accomplishes the same end in many different ways. She is rich in contrivances. The same warmth and moisture which promote the development of the living embryon also weaken the inanimate shell, by a process analogous to decomposition, and by a general expansion consequent upon the swelling of the embryon within. Thus the eggs when about to hatch are much more plump, and somewhat larger and more transparent, than they were when laid. At last, by the muscular efforts of the nascent locust and the swelling of its several parts, especially about the head and mouth, the shell gives way, generally splitting along the anterior ventral part. The whole process may, in fact, be likened to the germination of a hard covered seed when planted in moist ground, and, precisely as in this latter case, there is in some loose soils a certain heaving of the ground from the united swelling of the locust eggs. All the eggs in a given mass burst very nearly at one and the same time, and in that event the lowermost individuals await the escape of those in front of them, which first push their way out through the neck of the burrow provided by the parent.

When once the shell is ruptured the nascent larva soon succeeds, by a series of undulating movements, in working free therefrom and making its way to the light in the manner just described. Once on the surface of the ground, it rests for a few minutes, generally lying on the side. Its members are still limp and directed backward, and it is yet enveloped in a very

delicate film or pellicle, which must be cast off before the little creature can move with alacrity.

By continuance of similar contracting and expanding movements which frees the animal from the earth, this film in a very short time splits along the middle of the back near the head (strictly the prothorax), and is then worked off behind, and finally kicked from the hind feet in a little white, crumpled pellet, that has justly been likened by some of our correspondents to a diminutive mushroom. These little pellets invariably lie close around the hole in the ground from which the young locusts issued. The pellicle begins to split, under ordinary conditions of warmth, within a minute from the time the locust is fairly out of the ground, and is shed in from one to five minutes, according to circumstances. Pale and colorless when first freed from this pellicle, the full-born locust is nevertheless at once capable of considerable activity, and in the course of an hour assumes its natural dark gray coloring.

"From this account of the hatching process, we can readily understand why the female, in ovipositing, prefers compact or hard soil to that which is loose. The harder and less yielding the walls of the burrow, the easier will the young locust crowd its way out.

"Though the covering which envelops the little animal when first it issues from the egg is quite delicate, it nevertheless, in the struggles of birth, undoubtedly affords much protection; and it is an interesting fact, that while, as we have just seen, it is shed within a few minutes of the time when the animal reaches the free air, it is seldom shed if, from one cause or other, there is failure to escape from the soil, even though the young locust may be struggling for days to effect an escape."

WHERE AND UNDER WHAT CONDITIONS OF SOIL THE YOUNG HATCH MOST FREELY.

As may be gathered from experiments, the eggs will hatch under the most varied conditions. As a rule, the soils and locations preferred by the female in ovipositing will be those in which the young will most freely hatch, viz., compact and sandy or gravelly knolls and hillsides, with a south or south-east exposure.

The experience of 1877 shows also that hatching takes place very freely in late-mown meadows or prairies, or grazed pastures, where the exposure of the ground permits ready oviposition and the warmth of the sun. In dry, well-drained, and compact soils of a light nature, the eggs are much better preserved than in heavy clays and loams, where they are more subject to mould and rot. The experience of 1877 is rather misleading on this point, and indicates the necessity of generalizing, not from the experience of one, but of many years. The insects were most numerous and seemed to hatch most numerously in the low lands and in sheltered situations along river-courses. The facts are, that in such situations those which did hatch survived in larger proportions than did those which hatched in more exposed places, because the former were better protected from the cold rains and storms of spring.

TIME OF HATCHING.

Here, again, we cannot take the experience of any one year as a guide, but find the necessity of generalizing from all past experience. In much of the locust area there prevailed such late warm weather in the autumn of 1876 that considerable numbers of the young hatched prematurely, and such is very generally the case. We had also some unseasonably warm weather in January and February, 1877, during which large numbers hatched. These all subsequently perished. During the latter part of March and early in April the hatching was general, but there followed a period of cold, rainy weather, which checked the hatching and destroyed a large number of the insects that had hatched. May and June were characterized by abundant rains and storms, alternating with warm, sunny weather, causing the hatching to be irregular, and in some cases quite retarded. It would not be incorrect, therefore, to say, that in one and the same neighborhood the hatching commenced on the 1st of February, and did not cease till the end of June, thus covering a period of five months. Yet this is exceptional, and it has been much more regular and the period more restricted in previous years.

Those eggs which are laid earliest the previous year will also hatch earliest, and since, as we have already seen, the egg-lay-

ing covers an average period of six or eight weeks in the same locality, and lasts generally till frost, it follows that the eggs pass the winter in every state of development,—some with the fluids clear and limpid, others with the embryo fully formed, and ready at the first approach of spring to hatch. This we found also to be actually the case, for many hundreds of egg-masses examined during the winter of 1876–'77, from divers parts of the infested region, showed every state of development.

In the same locality hatching will take place—*cæteris paribus*—first, on light, dry soils, and on south and south-east exposures; latest, on low, moist, and shaded or tenacious ground.

We see, therefore, that the hatching will not alone vary according to temperature and the earliness or lateness of the spring, but that it is quite variable under the same conditions. In every instance there will be a few hatching when the first hatched in the same locality are getting wings, and we give it as a general rule that the bulk of the eggs hatch out in the different latitudes about as follows:

In Texas, from the middle to the last of March.

In the southern portions of Missouri and Kansas, about the second week in April.

In the northern parts of Missouri and Kansas and the southern sections of Iowa and Nebraska, the latter part of April and first of May.

In Minnesota and Dakota the usual time of hatching ranges from early in May, in the southern portions, to the third week in the northern extremity.

In Montana and Manitoba, from the middle of May to the first of June.

In short, the bulk of the insects hatch, in ordinary seasons, about the middle of March in latitude 35°, and continue to hatch most numerously about four days later with each degree of latitude north, until along the forty-ninth parallel the same scenes are repeated that occurred in Southern Texas seven or eight weeks before.

From a number of experiments which we have made on the eggs, we conclude that, with a constant temperature of 85° F., with favorable conditions of soil, the eggs will hatch in from

four to five weeks after they are laid, and in a temperature of 75° F. in about six weeks.

FOOD-PLANTS.

"The Rocky Mountain locust may be said to be almost omnivorous. Scarcely anything comes amiss to the ravenous hosts when famished. They will feed upon the dry bark of trees, or the dry lint of seasoned fence planks, and upon dry leaves, paper, cotton, and woollen fabrics. They have been seen literally covering the backs of sheep, eating the wool; and whenever one of their own kind is weak or disabled, from whatsoever cause, they go for him or her with cannibalistic ferocity, and soon finish the struggling and kicking unfortunate. They do not refuse even dead animals, but have been seen feasting on dead bats and birds. Few things, therefore, come amiss to them. Yet where food is abundant they are fastidious, and much prefer acid, bitter, or peppery food to that which is sweet."

It is quite evident, also, from the facts we have collected, that the insects act somewhat differently during different years in this matter of choice of food-plants, for at one time they will be particularly severe on some plants that had been passed by on a previous occasion. While, therefore, experience is often naturally conflicting as to their preferences and dislikes, the following *resumé* of our notes made during the past four years will prove interesting:

"Vegetables and cereals are their main stay. Turnips, rutabagas, carrots, cabbage, kohlrabi, and radishes are all devoured with avidity; beets and potatoes with less relish, though frequently nothing but a few stalk-stubs of the latter are left, and sometimes the tubers in the ground do not escape. Onions they are very partial to, seldom leaving anything but the outer rind. Of leguminous plants, the pods are preferred to the leaves, which are often passed by. Cucurbitaceous plants also suffer most in the fruit. In the matter of tobacco their tastes are cultivated, and they seem to relish an old quid or an old cigar more than the green leaf. Tomatoes and sweet potatoes are not touched so long as other food is accessible." Mr. W. D. Donaldson, of Headsville, Texas, reports a case in Limestone county,

in that state, where the insects, in 1876, were noticed to fall greedily upon a tobacco-patch of second growth, and where they died soon after eating thereof. Other cases of the injurious effect of tobacco upon them have been reported to us. It is more than probable, however, that the insects would also have been found to die elsewhere with further investigation, and that the death of those in tobacco-patches resulted from other and more natural causes, since late in the autumn they are constantly dying from exhaustion and senility. At all events, the evidence is not sufficiently general and uniform as to the hurtful effects of tobacco, to permit us to accept it as a demonstrated fact. Horse-radish is rarely touched.

Of cereals, corn is their favorite;—if young and tender, every part is devoured to the ground; if older and drier, the stalks are mostly left; the silk is, however, the first part to go. An impression prevails in Colorado that white corn is more proof against the insects than other kinds. All other cereals are to their taste, except sorghum and broom-corn, which are often left untouched.

It has been very generally remarked in Minnesota, that the bearded varieties of wheat are less damaged by the winged insects than the smooth varieties, and in 1877 the Red Osakee suffered less than the Fife. Oats and winter rye more often escape than other small grains. All the tame grasses are devoured with avidity. Wild prairie grass is relished when young and tender, but is usually little injured when mature. Yet cases are on record by travellers in the North-west, even during the last century, of the wild grass being so effectually mown down by these locusts as to render it difficult to find feed for horses; and Mr. R. M. Probstfield, who has resided at Moorhead, Minn., since 1859, relates that in 1864 the locusts cleaned off the wild grass, and stripped the trees of leaves to such an extent that the timber wore a wintry aspect.

The insects are fond of buckwheat and flax, but less fond of the castor bean. Indeed, statements have been repeatedly circulated in the agricultural press that this plant is proof against the locust; but they are incorrect and delusive. The plant is not liked, and ordinarily is passed by, or merely nibbled at. The flower is more often devoured than any other part, but the

whole plant is not unfrequently ruined. There is a general belief that this plant also acts as a poison on the locusts, but we have been unable to obtain any positive evidence of the fact, and the belief probably arose in the same way as that regarding tobacco.

Last summer we met with several instances where Hungarian grass had been sown on wheat land where the wheat had been badly injured, but the grass was so much liked that the locusts never allowed it to come up. The young insects in spring sometimes kill out a blue-grass pasture, but more generally it recovers from their attacks, and wild grasses always do. "Young corn is eaten down so often and so deeply into the ground that it is frequently destroyed. Potatoes are not killed by being eaten down, and generally make a crop after the insects leave, without replanting. This is especially the case when they are planted deep, and where the vines as they grow are at first kept covered with earth, which they can be with impunity. The blossoms and stems of pease are left after the leaves are stripped, and parsnips sometimes remain untouched."

Next to vegetables and cereals, they relish the leaves of fruit-trees; they strip apple- and sweet cherry-trees, leaving nothing but the fruit hanging on the bare twigs. The leaves of the peach are generally left untouched, but the flesh of the unripe fruit is eaten to the stone. Pear-trees, according to Professor Gale, suffered less in 1874 than any other kind of orchard tree at the experimental farm of the Agricultural College at Manhattan, Kan. The tender bark of twig, and branch, and trunk of all these trees is gnawed and girdled, and these girdled trees present a sad picture as one passes through the ravaged country during the subsequent winter. Sour cherry-, apricot-, and plum-trees are less affected by them, while ripe fruit is seldom touched. Mr. Donaldson, of Headsville, Texas, gives as a singular fact, that with him the insects did not eat the young peaches on his trees that were on branches leaning below the horizontal. Grape-vines generally suffer more from the girdling of the fruit-stem than from defoliation.

Of berries, raspberries seem to be the most exempt, and this is interesting when we reflect that wild raspberries are common in the North-west country. Strawberries and blackberries suffer

more, strawberry-beds being frequently ruined. Flowering shrubs generally suffer, especially rose and lilac.

"Forest and shade-trees suffer in different degrees, and some, when young, are not infrequently killed outright. In 1874, honey locust, red cedar, box elder, osage orange, elm, and oak were either untouched or but little injured, while the following trees were preferred in the order of their naming: ash, willow, cottonwood, balm of Gilead, silver-leaved and Lombardy poplars, black ash, black locust, black walnut, hickory, ailanthus, maple, sumach, and evergreens." In 1876 it was observed that the coffee bean, beech, and soft maple were more particularly untouched. It is generally supposed that evergreens are avoided, but they suffer all the more that they are so much more sensitive to defoliation than deciduous trees. Hemlock, arbor-vitæ, the pines, and especially the Norway spruce, are often stripped. The red cedar more often escapes, and is, for that reason, called the *iron-clad evergreen* by some of our Western nurserymen. The Austrian and Scotch are also less affected than other pines. Our experience in 1877 would indicate that of all trees the blue ash is most liked, for we found it everywhere badly eaten, even where other trees were untouched.

Of wild, herbaceous plants, mayweed or dog-fennel *(Maruta)* is a favorite, but smartweed is liked above all. Indeed, the black bindweed *(Polygonum convolvulus*, L.), which is very common in Minnesota, where it is often called wild buckwheat, is so universally preferred by the locusts that some farmers have thought seriously of cultivating it around their fields, as a lure to draw the insects off from the cultivated crops, and thus facilitate the killing of the pests.

To sum up, where the insects are abundant, the prairie-grass, the wild weeds mentioned as disliked, and the leaves of most of the forest trees generally remain green, but the little amaranthus is the only plant which we have so far found proof against the insects under all circumstances. A marked preference is always shown for plants that are unhealthy or wilted, and a dislike for those in low, wet, or marshy places.

In concluding these notes on the food habits of locusts, we will briefly refer to a rather prevalent belief that the newly-hatched locusts live for many days on dew. The belief has

originated independently in different parts of the world, is mentioned by Anacreon and Hesiod, and perpetuated by later poets. It is doubtless due to the facts that if the weather be cool, the young insects huddle together, and can live for several days without feeding; that the nibbling and fretting of these young is hardly noticeable; and that, as we have abundantly proved the past summer, these insects are fond of drinking at all stages of growth.

MORE DEFINITE DESCRIPTION.

Since the preceding pages were given to the printer and put in type, the Secretary has received a more extended and definite description of the pest, which Mr. Riley denominates the *Caloptenus atlanis*, or the LESSER MIGRATORY LOCUST. Mr. Riley says it is the Eastern prototype of the Rocky Mountain locust, and that their appearance in our state dates back to 1873. The next year they appeared in force, between Concord and Franklin, on the Merrimack, to which section they have been generally confined.

On certain farms, at that time, especially on those of John K. Chandler and Col. D. M. Clough, in Canterbury, they stripped the fields of every green thing. In a single day they destroyed several acres of nearly full-grown clover on the farm of the Secretary of the Board of Agriculture in Boscawen. They immediately made an advance northward to the "Webster Place," at Elms Farm, and caused serious destruction to crops. Extending south into Concord, they took possession of the old Sewall's island, now the farm of Hon. Moses Humphrey, Chairman of the State Board of Agriculture, ruined acres of grass, and made inroads on his corn-fields.

Prof. Riley gives the following characteristics of the insect:

Length to tip of abdomen 0.70–0.85 inch in the adult; to tip of closed wings, 0.92–1.(5 inches. At once distinguished from *femur-rubrum* by the notched character of the anal abdominal joint in the male, and by the shorter, less tapering cerci; also by the greater relative length of wings, which extend, on an average, nearly one third their length beyond the tip of the abdomen in the dried specimens; also by the larger and more distinct spots on the wings—in all which characters it much more

closely resembles *spretus* than *femur-rubrum*. From *spretus*, again, it is at once distinguished by the smaller size, the more distinct separation of the dark mark running from the eyes on the prothorax and of the pale line from base of wings to hind thigh; also by the anal joint in the male tapering more suddenly, and by the two lobes forming the notch being less marked. From both species it is distinguished not only by its smaller size, but by the deeper, more livid color of the dark parts, and the paler yellow of the light parts—the colors thus more strongly contrasting.

Aside from its smaller size, throughout its growth this species may be distinguished as follows: In the first stage it is more uniformly and distinctly dotted with black, the legs being strongly dotted and banded, and the hind thighs being darker and showing much more distinctly the pale transverse streaks. In the second stage the color is more livid or rosy, with a more strongly contrasting yellow venter. In the subsequent stages, these colorational differences still prevail, and the face is not black as in *spretus;* the pale spot on the hind wing-pads is less conspicuous in the fourth stage, and the pupa is distinguished, not only by its smaller size and different color, but by the narrower, more obsolete black marks of the prothorax and by the wing-pads being considerably shorter and smaller, the hind pair livid, with only rarely a touch of black at base, and with the pale spot sub-obsolete. The pale streaks on the outside of the hind thighs are always conspicuous. It presents, in fact, a marked contrast to the pupa of *spretus*. *Atlanis* invariably has a pale face—yellow or greenish, speckled with gray-brown; and, just as invariably, the outside of the hind thighs more mottled, with pale oblique streaks through the black.

Unlike the Rocky Mountain locust, the permanent breeding grounds of which are limited to but a portion of the vast territory which it occasionally overruns and ravages, *C. atlanis*, in common with *C. femur-rubrum*, has a very extended natural range, breeding annually in abundance from middle Florida to the sub-boreal portions of Canada. Our experience of the past five years, during which we have visited and examined the locust fauna in many sections along the Atlantic from Quebec to northern Florida, would indicate that it is much more prevalent

than *femur-rubrum*, and is, in fact, the common social and migratory species of the East. In many parts it entirely replaces *femur-rubrum*, and we have been astonished to find that of the thousands of specimens examined in Massachusetts and New Hampshire during 1882 and 1883, all, without exception, have been *atlanis*. As we approach the Mississippi this condition of things is changed, and *femur-rubrum* generally predominates, and in some localities entirely replaces *atlanis;* while in the great plains west of the Mississippi both are supplanted by *spretus*. *Atlanis*, with several closely allied forms, reappears again toward the Pacific in the more northern portions, ranging south to the 40th parallel, approximately, in Utah and California.

The eggs and the egg-mass are so similar to those of *C. spretus* that there is no other difference than in the somewhat smaller size of either. They are laid just beneath the surface of the ground in precisely the same manner. Each female in the course of her life usually deposits two of these masses, though at St. Louis we have observed instances in which three and even four were placed by the same female. It is in the egg state that the insect passes the winter and the young locusts hatch in the spring.

The average period between hatching and maturity we found at St. Louis to be eighty days, or some ten days longer than in the case of *C. spretus* and *C. femur-rubrum*, but in New Hampshire it is probably somewhat longer.

In about one week after reaching full growth the insects pair, and soon thereafter commence ovipositing. There is undoubtedly but one annual generation in New England, whereas in Missouri we found uniformly two. In the Merrimack Valley the hatching period extends throughout May, and most of the individuals have become winged by the early part of July. Oviposition continues from the latter part of July till frost. Some of the earlier laid eggs hatch in autumn, so that there is the same tendency toward a second brood as we find in *spretus*, a tendency which is more marked during a warm, protracted autumn, and which is beneficial to the farmer, inasmuch as all these autumn-hatched individuals invariably perish during the winter.

It has been demonstrated that the breaking up of the egg-pod and the exposure of the individual eggs to the influence of the weather prove fatal to the embryo; hence we have recommended harrowing the fields in late autumn or during any mild weather in early winter. In the light sandy soil which prevails around Boscawen, we strongly recommend this method in such fields as are in cultivation, and in which the eggs are thickly laid.

As regards deep plowing in late fall and early winter, burying the eggs to a considerable depth, experience varies according to the nature of the soil and the depth of the plowing. But it is strongly to be recommended if done thoroughly, as it not only prevents the bulk of the young locusts from successfully hatching and reaching the surface, but the exceptional ones which survive the operation hatch so much later that they would not affect the first crop of hay.

The use of the trapping pan or scoop, already mentioned, is recommended by the entomologist. He says,—

The use of the kerosene pan in New Hampshire has met with an abundant measure of success, although the experiments were begun this year rather too late. From the second week in June on, daily draggings were made on at least six farms, and as many as a bushel of locusts taken in an hour from a single pan, without reckoning those which had jumped out and died on the ground from the effects of contact with the kerosene. On the farm of J. K. Chandler, where we made our first experiments, operations were begun early in June, and steadily continued until the locusts became full fledged. On one occasion fifteen bushels were gathered in one hour, and upon an adjoining farm [Col. Clough's] a bushel were taken in two minutes. On a four-acre field to the north thirty-six bushels were caught in two days. Instead of the pure kerosene thrown into the pans, either with or without water, as heretofore used in the West, we found that the kerosene emulsion—*i. e.*, milk and kerosene mixed—acted admirably when diluted even with 50 to 100 parts of water, while the locusts were young; so that as a matter of economy and convenience the use of the oil in this form well repaid the trouble of preparation, which rarely requires more than from five to ten minutes of churning with an ordinary aquapult.

Coal-tar may be used with most of the contrivances just described for the use of kerosene, and while not equal to the simple kerosene pan for speed in trapping and destroying, is yet very useful, especially in the neighborhood of gas-works, where the coal-tar can be obtained at a nominal cost. It also permits the use of the simplest kind of pan.

A simple pan, which was very extensively used in the West, is known as the "Robbins Hopperdozer." Its general plan is that of an ordinary road-scooper, and its simplicity and durability account for its general use. It was usually drawn by hand, though several pans were frequently bound together and drawn by horses; while in some instances certain improvements in the way of mounting on wheels, so as to permit its being pushed from behind, were also adopted. We saw some with a wire screen, or cover, hinged to the back so that the insects might be secured when the pan was not in motion, but the cover seemed superfluous. We also saw lime and kerosene mixed so as to form a mortar substituted for the coal-tar.

On the New Hampshire farms it becomes necessary to devise some remedy for use in the vegetable gardens where the machines just described, and which are for field use, cannot be advantageously operated. Here the kerosene emulsion which we have so frequently recommended of late again comes into play. An emulsion resembling butter can be produced in a few minutes by churning with a force pump two parts of kerosene and one part of sour milk in a pail. The liquids should be at about blood heat. This emulsion may be diluted with twelve parts of water to one part of emulsion, thoroughly mixed, and may be applied with the force-pump, a spray-nozzle, or with a strong garden syringe. The liquid will kill all locusts which it touches without harming the vegetables.

An equally good emulsion may be made as follows:

Kerosene, ...	2 gallons	$=66\frac{2}{3}$ per cent.
Common soap, . . .	$\frac{1}{2}$ pound	$=33\frac{1}{3}$ per cent.
Water, ...	1 gallon	

Heat the mixture of soap and water and add it boiling hot to the kerosene. Churn the mixture by means of a force-pump

and spray-nozzle for five or ten minutes. The emulsion, if perfect, forms a cream, which thickens on cooling, and adheres without oiliness to the surface of the glass. Dilute with cold water before using, to the extent which experience will indicate is best, and which will differ according to the plants to be sprayed or to the size of the locusts to be killed.

MISCELLANEOUS CHAPTER.

During the past year the Secretary and a few members of the Board have made investigations and experiments which will prove of value in the line of progress. They have caused a few analyses to be made of fertilizers and special articles for the benefit of the farmer.

ANALYSES.

The Secretary obtained from Hon. George K. Harvey, of Surry, member of the Board from Cheshire county, a sample of his ensilage, and also a can of the manure made by cattle feeding entirely on ensilage.

This examination, and that of other materials, were made at the laboratory of the College of Agriculture, by Mr. Burleigh, of Franklin, a resident graduate. Professor Blanpied supervised the work.

	Ensilage.	Manure.
Moisture,	84.607	83.890
*Volatile and organic matter,		13.272
Ins. matter, sand, etc.,		.388
Silica soluble,		.005
Phosphoric acid,		.163
Sulphuric acid,	.071	.034
Ferric acid and alumina,		.020
Ash,	9.53	
Acetic acid,	.028	
Fibre,	3.880	
Sugar, glucose,	.530	
Potash,		.140

*The nitrogen in the manure is given as .496, or one half of one per cent., ten pounds to a ton, or, on a basis of nitrogen in the muck hereafter given, is worth $2.00.

Soda,	.023
Sodic chloride,	.012
Carbonic acid,	.700
Magnesia,	.470
Lime,	.884
Albuminoids—Nitrogen × 6.25 = 1.25.	
Garbohydrates—not sugar extract,	7.552

MAIZE FODDER AND ENSILAGE.

Prof. Johnson, at the Connecticut Station, examined maize fodder sowed somewhat thickly in drills, also field corn in hills less thick. This was done September 1, 1881.

Prof. J. says analyses were made with the prime object of learning something of the kind and degree of chemical change which occurs in the silo. As a control on the results, duplicate samples of the fresh maize stalks were separately examined in order to ascertain what amount of variation in the analyses is attributable to imperfect sampling, it being evidently no easy matter to take from a mass of maize stalks two small portions that exactly correspond in composition to each other, or to the mass.

Comparing, on water-free substance, the composition of the ensilage with that of the corn itself, we get no satisfactory evidence of any change in the albuminoids, for the amount found in the field corn ensilage is but 1.34 per cent. less than the average result on the field corn itself, while in case of fodder corn the albuminoids found in the ensilage are 1 per cent. more than the average obtained in the fresh corn. As regards the "ether extracts," we observe that in both cases the ensilage contains very nearly double what was got from the fresh corn. In ordinary fodder-analyses the ether extract consists for the most part of oil, fat, or wax, and is usually termed fat or crude fat. In the process of ensilage it is not so likely that fat is produced as that lactic acid is formed, perhaps mainly during the sampling and sending (by transformation of sugar), which dissolves freely in ether.

That sugar and perhaps other carbohydrates are to some degree destroyed and lost by fermentation in the silo, is proved by the appearance of fermentation-products, especially carbonic acid

gas. Such loss would tend to diminish notably the percentage of nitrogen-free extract and to increase that of the crude fiber. At first glance the analyses of the field corn and its ensilage would seem to indicate a considerable loss in this way, for the fiber of the ensilage is nearly 4 per cent. greater than that of the corn, and its carbohydrates, etc. (N. fr. extract), nearly 5 per cent. less. But the results for fodder corn, though pointing in the same direction, give much smaller differences (0.2 per

	Field Corn.		Fodder Corn.	
	Fresh.	Ensilaged.	Fresh.	Ensilaged.
Water	79.72	82.38	87.15	87.68
Ash	1.07	1.05	.87	.91
Albuminoids*	1.78	1.39	1.54	1.38
Crude fiber	4.73	4.80	4.19	4.04
N. fr. extract †	12.46	9.96	6.06	5.62
Ether extract (fat, etc.)	.24	.42	.19	.37
	100.00	100.00	100.00	100.00
Water Free.				
Ash	5.26	5.98	6.77	7.42
Albuminoids*	8.79	7.87	11.95	11 25
Crude fibre	23.33	27.24	32.62	32.83
N. fr. extract †	61.48	56.56	47 20	45.50
Ether extract (fat, etc.)	1.19	2.35	1.46	3.00
	100.00	100.00	100.00	100.00

cent. less fiber and 1.7 per cent. more N. fr. extract), differences that bear no proper relation to each other to be accounted for by loss in fermentation, and that are easily attributable to errors of analysis and uneven sampling. Even the larger differences of 4 and 5 per cent. found in case of the field corn might be due to differences in the original samples, for if in the albuminoids there could be in two samples a difference of 3.4 per

* Reckoned as total nitrogen × 6.25.

† Nitrogen-free extract includes carbohydrates (sugar, gum, etc.)

cent., twice that variation should be anticipated on the three times more abundant fiber and carbohydrates.

We conclude, then, that these analyses demonstrate that this method of working is incompetent to give any clear notions as to the quantity or even as to the kind of changes that go on in the silo. This result was not unexpected;—nevertheless, we regarded the questions involved worthy of careful experimental study.

The antiseptic quality of acids, especially of carbonic acid gas, which has lately been demonstrated by Kolbe, is such as to lead to the conclusion that no considerable amount of chemical change or of loss of nutritive matters can go on in the well constructed silo. Dr. Neale has, we believe, found further experimental evidence of that conclusion in recent investigations at the New Jersey Experiment Station.

An experiment was made by Mr. Hazard, of Rhode Island, with ensilage of the best quality, which showed a nutritive value equal to two fifths of good hay,—ensilage two, to hay five,—the ensilage costing about $7.50 for one ton of hay, which is worth about $12.

MUCK.

Two samples were taken by the Secretary from a muck-bed in Boscawen, on the farm of Joseph Wilson. It laid in the open air a full year. It was then analyzed at the college laboratory in Hanover.

No. 1 was taken from the surface of the muck bed after removing the dry material that had collected. The second sample was taken from directly below the first, at a depth of two feet. The result of the examination is,—

	I	II	
Insoluble inorganic matter, . .	1.2	63.339	per cent.
Moisture in loss at 100°, . .	42.46	3.965	
*Organic and voltaic matters, . .	56.12	31.825	
Silica, soluble, ...	.015	.206	
Chlorine, ...	.011		
Phosphoric acid, ...	.005	.163	
Sulphuric acid, ...	.055	.071	

*Contains humus,	41.38	25.53
Contains nitrogen,	2.40	1.73

Ferric acid and alumina, . . .	.078	.230
Traces of potash, soda, magnesia, and lime.		
Free ammonia, ...	.059	

The manurial value is in the nitrogen, which at 20 cents per pound would be nearly $9.20 per ton for No. 1, and $6.80 for No. 2. But it must be borne in mind that a large mass of dried muck will be required to give one ton's weight.

It will be seen that this muck is valuable. The proportion of humus makes it evident that vegetable matter is its leading constituent. The fact that the upper layers have more nitrogen than the under ones would indicate that the muck absorbed ammonia from the atmosphere, or that it had not washed down. This would be confirmed by the fact that in No. 2 there is less nitrogen. Ammonia is generally carried down by the rains, though in this case the upper portion holds it.

Professor Johnson, of the Connecticut Experimental Station, reports several analyses of muck as follows;

	1	2	3
Water, ...	70.51	79.66	80.16
Organic and volatile matter, . . .	24.80	17.85	16.95
Containing nitrogen, ...	1.08	.66	.59
Ash, ...	4.69	2.49	2.89
In which are silica and insolubles, . .	1.67	.42	.51
Alumina, phosphoric acid, &c., . .	.63	.19	.27
Lime, ...	1.37	.74	1.14
Undetermined, ...	1.02	1.14	.97

On the same basis as those of our own reported, the nitrogen in these samples is worth $4.32, $2.64, and $2.36 respectively. In these are small amounts of phosphoric acid and lime of some value, but very small.

Mr. Johnson took the same mucks dried, and gave as the result of his examination the following:

	1	2	3
Organic and volatile, ...	84.09	87.75	85.43
Nitrogen, ...	3.66	3.24	2.97
Silica and insolubles, ...	5.66	2.07	2.55
Iron, alumina, &c., ...	2.14	.93	1.36
Lime, ...	4.64	3.84	5.75

The manurial value per ton of these mucks estimated dry would be $14.64, $12.96, and $11.88. These are rare samples, and it appears they must be over-estimated.

PURE GROUND BONE.

The Maine report contains analyses of Belknap & Sons' Bone, Portland, which has been used in this state. The analysis is as follows:

Nitrogen,	4.	per cent.
Phosphoric acid, insoluble,	20.62	"

Valuation.

Nitrogen, 80 pounds,	$20.80	
Insoluble phosphoric acid, 412 pounds,	24.74	
		$45.54
Sold at factory price,		39.00
Value above cost,		$6.54

This corresponds with our own experience. We have tested Belknap's bone in the soil and in the laboratory, and had occasion to say, as we did say, in one of our reports, that it ranked very high, on the same plane with Kerwin's, not now made, and Bowker's.

Secretary Gilbert puts Bowker's as follows:

Nitrogen,	4.34	per cent.
Insoluble phosphoric acid,	20.23	

Valuation.

Nitrogen, 86.8 pounds,	$21.56	
Insoluble phosphoric acid, 404.6 pounds,	24.27	
		$45.83
Cost,		39.00
Value above cost,		$6.83

We believe these are called $40 per ton in small amounts, but in large quantities may be purchased at $38.

CHEMICAL FERTILIZERS.

Mr. Gilbert gives the composition of several of the Stockbridge manures, and of Bowker's, from the same manufactory, and reports nearly all of a value under the cost. In some of these there are elements not employed in the common manufactures, which the chemist has not usually taken into account, such as soda, magnesia, &c. This class of fertilizers are marked high, but they are generally effective. If they could be put ten per cent. lower they would meet with a ready sale in New Hampshire.

THE CUMBERLAND SUPERPHOSPHATE.

This is sold in the northern part of our state, and perhaps to some extent in the eastern section. It is a good article as generally made.

Nitrogen,	2.29 per cent.,	=45.8 lbs.,	=$11.91
Soluble phos. acid,	7.80	156.0	19.50
Reverted "	1.83	36.6	3.29
Insoluble "	3.04	60.8	3.65
Potash,	3.25	69.0	4.87
Value,			$43.22
Cost,			40.00
Analysis above trade price,			$3.22

BRADLEY'S XL SUPERPHOSPHATE.

Nitrogen,	2.22 per cent.,	44.4 lbs.,	=$11.54
Soluble phos. acid,	8.33	166.6	20.82
Reverted "	1.57	31.4	2.82
Insoluble "	2.05	41.0	2.46
Potash,	2.44	48.8	3.66
Value,			$41.30
Cost,			42.50

In small quantities in this state the price is $45.00,—in large amounts, $40.00. The only complaint made regarding Bradley's is, that it is not so dry as some other brands. It meets with a ready response when properly used.

BAY STATE.

Nitrogen, . . .	2.62 per cent.,	52.4 lbs.,	=$13.62
Soluble phos. acid, .	7.75	155.	19.37
Reverted " . .	.86	17.2	1.55
Insoluble " . .	.66	13 2	.79
Potash, ...	1.27	25.4	1.90
Value, ...			$37.23
Cost given by Mr. Gilbert, .			40.00

DOLE'S COMMON-SENSE FERTILIZER.

Several analyses of this article have been recently made, as it is comparatively new and claims to be cheap. There is a general harmony in the results. All agree that the cost is too high for the value.

The Maine Report says,—

Nitrogen, . . .	2.71 per cent.,	54.2 lbs.,	=$14.09
Soluble phos. acid, .	.60	12.	1.50
Reverted " . .	2.24	44.8	4.03
Insoluble " . .	1.81	36.2	2.17
Potash, ...	4.75	95.0	7.12
Value, ...			$28.91

Cost, $35.00;—above value, $6.09.

Our own examination corresponds very nearly with Mr. Gilbert's.

TRIAL OF SEEDS AND SHRUBS.

The Secretary has received, within the past year, seeds, plants, cuttings, and shrubs, for experimental work from parties indicated below. These have been tested on his own grounds, or put into the hands of members of the Board and others. Reports in brief of these are given, so far as any returns have been made.

FRANK FORD & SON, of Ravenna, Ohio, Sunnyside Nursery. Lee's Favorite Potato—One of the best of the new varieties, light colored, similar to the Early Rose, but smoother and fairer,

and of the best cooking quality. From thirty-six single sets ninety pounds were produced.

Ford's Early Sweet Corn—The earliest grown in this section, and of fine quality.

Alpha Tomato—None better.

Early Colton Apple Scions—Made a fine growth.

JEROME B. RICE & Co., Cambridge Valley, New York. Early Sunrise Potato—A rare variety, early, smooth, shallow eyes, and of first class quality. Seven bushels were produced from six pounds of seed on sandy loam. The potatoes were put into the ground May 22d, had not previously germinated, came up in one week with very stout stalks, and were large enough to eat in fifty-one days.

Also a full assortment of vegetable and floral seeds. These have been tested by the Secretary and members of the Board with very rare failures.

H. S. ANDERSON, Cayuga Lake Nurseries, Union Springs, N. Y. Ten varieties of strawberries, eight of which gave good results, the Seneca Queen and one other only proving failures.

Six varieties of raspberries, which for the first year made good growth, though somewhat pinched by drouth.

Fay's Prolific Currant and some other articles made fair growth.

A choice assortment of grape-vines, which were all alive in October.

From HIRAM SIBLEY & Co. were received a full assortment of garden seeds, with samples of field seeds. Most of these were placed in the hands of gardeners in small quantities, who, reporting generally, have not given the details desirable.

Beans—Black Wax, dwarf, Ivory Pod Wax, Soja, Red Kidney.

Broccoli.

Collards.

Peas—First and best, Blue Peter.

Tomatoes—Acme, Rochester, Essex Early Hybrid, Hathaway's Excelsior.

Barley—Sibley's Imperial.

Onions—Bermuda, Yellow Danvers, Large Red Wethersfield, Large Red Ital. Tripoli, Large White Ital. Tripoli.

Cabbage—Excelsior, Early Etampes, Fottler's Brunswick, Little Pixie, Stone Mason, St. John's Day.

Lettuce—Black Seeded Satisfaction, White Tennis Ball, Prize Head, Large Drumhead, Early Curled Silesian, American Gathering, Green Fringed, Giant White Cos.

Gauliflower—Algiers, Early Dwarf, Erfurt.

Musk Melon—Surprise, Christiana, Bay View.

Water Melon—Scaly Bark, Phinney's Early, Cuban Queen.

A few items from our garden note-book are given.

"Little Gem" Peas—Planted April 14, came up May 2, first blossom June 3, gathered a few June 17, harvested for seed July 13.

"First of All" Peas—Came up May 1, first blossom June 1, first picking June 17, plump and full; harvested July 13.

"White Mustard"—A failure so far as first crop is concerned. It germinated slowly, came up weak and slender, but little matured seed.

"Beauty of Hebron" Potatoes—Planted April 14, came up May 20, blossomed June 15, dug for table July 4.

"Little Wonder" Peas—Planted April 22, came up May 11, small vines, abundant pods, well filled and early.

May 2 planted peas, seed from Hiram Sibley & Co., Rochester.

"First and Best"—Came up May 17, blossomed June 8, picked June 25.

"Blue Peter"—Came up May 18, picked July 4.

"Advance," from Department of Agriculture, McLane's Advance—Came up May 20, picked July 4.

"Day's Sunrise"—Blossomed June 10, picked July 4.

"Early Vermont"—Seed sent by Dr. Hoskins. A good pea, came up May 20, blossomed June 10.

Merrill's 103 Potato—A vigorous, hardy grower, and good yielder, not yet much known. Seed from Mr. Merrill, of Newbury, Mass.

SEED TESTS.

BY W. H. HILLS, PLAISTOW.

The following tests of seeds in the spring of 1883, as shown in the table, were made in my green-house, where the degree of moisture and temperature is under perfect control, and where all the conditions of success are most favorable. The soil used was good, had been under cover during the winter, and all rocks and coarse lumps that might obstruct the seed germs carefully screened out, as is the practice in sowing the most delicate flower-seeds. In sowing in seed boxes, or "flats" as they are called, the depth is regulated with perfect accuracy, so that there can be no failures arising from too deep covering, cold storms, heavy, lumpy soil, or drying up, that the seedsmen talk so much about in their catalogues. It is true that we cannot "tread back on the rows" in seed boxes, in the new patent method invented by one brilliant genius, but all other conditions are favorable. That good seeds often fail in the open ground from causes here named there is no question, but in the green-house there can be no such excuses offered. If seed does not germinate under such circumstances, it is because it is worthless. The seed-seller may know that it is old, defunct trash, or he may not, but as seed growing and selling is his business, he ought to know all about the goods he deals in. Such varieties as are grown by himself or under his special supervision there should be no mistake about; and purchased stock, whether imported or otherwise, should be carefully tested before sale. It should be borne in mind that germination simply proves that a seed has vitality: it may even then prove to be untrue to name, and of some worthless variety.

A few of the seeds tested as here enumerated were sent to the Board of Agriculture for that purpose, and in such cases prudent seedsmen would be likely to send out stock that they supposed to be fresh and genuine. Most of the seeds, however, were purchased at full prices, without any intimation as to the use to be made of them.

I have also given the results of a few experiments with onion seed in the open ground, on a half-acre plot that has been sown to onions six years. The field was sub-divided into plots of ten

rows each, 125 feet long, and the different kinds of seed were sown in these plots alternately and repeated, so that no variation in the soil, which was quite uniform, might affect the result.

TABLE—PER CENT. OF GOOD PLANTS.

	No. 1.	No. 2.	No. 3.	Total.	Per cent. good pts.
CABBAGE. *From Joseph Breck & Son.*					
Early Wakefield	4	0	2	6	4
Early Winnigstadt	50	20	10	80	70
Henderson's Early Summer	25	22	3	50	47
Early Wakefield, "L"	75	12	10	97	87
Early Wakefield, "D"	10	5	6	21	15
Imported Brunswick	25	8	10	43	33
Stone Mason	6	0	18	24	6
Drumhead Savoy	60	8	10	78	68
Red Dutch	50	0	30	80	50
American Imported Savey	60	0	28	88	60
From Hovey & Co.					
Early Wakefield	25	42	4	71	67
From Everett & Gleason.					
Early Wakefield	4	0	1	5	
From Farquhar Bros.					
Early Wakefield	4	0	1	5	4
From Parker, Gannett, & Wood.					
Early Wakefield	4	0	14	18	4
From Hiram Sibley & Co.					
St. John's Day	10	9	0	19	19
Stone Mason	60	0	12	72	60
CAULIFLOWER. *100 seeds from Hiram Sibley & Co.*					
Algiers	40	0	16	56	40
From Everett & Gleason.					
Snowball	52	6	6	64	58
Veitch's Autumn Giant	25	14	9	48	39
LETTUCE—*from H. Sibley & Co.*					
Prize Head	50	0	26	76	50
Maltese Drumhead	25	0	23	48	25

Having suffered loss by poor onion seed in years past, I have grown my own seed for several years, and was anxious to test it by the side of that of other growers of good reputation. Until recently, onion seed has been very high, ranging from four to six dollars a pound, and even higher. This has made the temptation to sell old and adulterated seed very strong, and the loss arising from the fraud, both in the expense of seed and by the failure of the crop, has been very great. Four pounds of *good* seed to the acre is sufficient, but I have sometimes sown six and even eight pounds without obtaining more than half a "stand" of plants, and this when the seed cost four and six dollars a pound. When such failures occur the loss in the crop alone will amount to from two to four hundred dollars an acre.

In this experiment the difference in the plots was very marked during the entire season, so great that it could be seen thirty rods distant. It attracted the attention of the most casual observers, and led to many inquiries as to the cause.

One other result is worthy of remark. Nothing like fifty per cent. of the seed on Plot 5 germinated, yet the bulbs, owing to their greater distance apart, attained a larger size, and gave more bushels to the acre, than was anticipated before harvest. On the other hand, Plot 2 would have given a much greater yield if not more than two thirds as much seed had been sown, or if the plants had been thinned early in the season. It will be seen, both from the table of tests under glass and in the field, that seed two years old may give quite satisfactory results, but it will require two or three days longer to germinate.

I had suspicion, after trying one or two samples of Early Wakefield cabbage seed, that all the seed in the market was poor. In fact, Everett & Gleason refused to sell their seed, but gave me a package for testing. This led me to test the seed of other dealers, with what results will be seen above. It would seem probable that their stocks were all from the same source. It will be seen that the seed *ran very even*, as 100 seeds of four different lots, from as many different dealers, gave just four good plants each, with none that could be classed as No. 2. The 400 seeds gave 16 good plants, and 22 that were worthless. The result shows the test to be reliable, as all the seeds were treated precisely alike.

Each of these samples of Wakefield cabbage seed had printed upon the package in very small type,—so that the purchaser would be sure to notice it, of course,—the following "mutual agreement:"

> "While we exercise the greatest care to have all our seeds pure and reliable, it is hereby mutually agreed between ourselves and the purchaser of this package, that seeds sold by us we do not warrant in any respect, and are not in any respect liable or responsible for any loss or damage arising from any failure thereof."

Comment would seem to be unnecessary. That no seed-dealer having confidence in the purity and reliability of his goods would ever print this sneaking "While we" pretended "mutual agreement" upon the envelope containing his seeds, is quite certain. The pretence that the purchaser ever enters into any such mutual agreement is false, and the claim that "the greatest care is exercised to have all seeds pure and reliable" is equally false. The label amounts simply to a notice to the purchaser—if he ever sees it at all—that the seller reserves the right to dispose of any old, spurious, and adulterated trash he chances to have on hand, without regard to consequences.

TABLE—PER CENT. OF GOOD SEEDS.

	No. 1.	No. 2.	No. 3.	Total.	Per cent. of good seeds.
ONION. *From Department of Agriculture, Washington, 50 seeds.*					
Red Globe	13	0	7	20	26
Yellow Globe Danvers	4	0	3	7	8
Yellow Cracker	17	0	10	27	34
Home-grown seeds.					
Yellow Danvers (seed of 1881)	25	0	12	37	50
Yellow Danvers (seed of 1882)	33	0	2	35	66
From E. M. Lyman.					
Danvers Yellow	0	3	1	4	0

There are plenty of reliable seedsmen, who have confidence both in their seeds and in their patrons, who are always ready to refund the purchase-money, or furnish other seeds in case of

failure, and the purchaser should buy of such, and give the "while we" dealers a wide berth. Never purchase a package of seeds containing the above label. The man who enters into this "mutual agreement" deliberately, deserves to be cheated.

1883. *Experiments with Onion Seed, Feld-culture, in ten-row Plots, rows 125 feet long; variety, Yellow Danvers.*

Plot 1. Seed from Everett & Gleason, Boston, gave 92 pounds to a row, or 920 pounds.

Plot 2. Home-grown seed, crop of 1882, gave 105 pounds to a row, or 1,050 pounds.

Plot 3. Home-grown seed, mixed crop of 1881 and 1882, gave 90.875 pounds to a row, or 908.75 pounds.

Plot 4. Home-grown seed, *old*, crop of 1881, gave 74.875 pounds to a row, or 748.75 pounds.

Plot 5. Seed from Parker & Gannett, Boston, grown by Daniel Buxton, gave 62.75 pounds to a row, or 627.50 pounds.

This crop of onions was carefully measured in the field at harvest, but the memoranda of the result are not to be found at the time of writing. From recollection I am able to say that the result did not differ essentially from that shown above.

MEDICINAL DOSES—*Prescribed by* DR. W. H. H. MASON.

For full-grown animals, allowance to be made for younger ones.

DISEASES.	MEDICINES.	HORSES.	CATTLE.	SHEEP.	REMARKS.
Fever and stoppage in bowels.	Epsom salts.	Not to be used.	½ pound.	2 or 3 oz.	
Fever.	Calomel.	1 teaspoonful.	1 teaspoonful.	40 grains.	Given in tissue paper, folded and dropped well down.
Coughs and colds.	Thoroughwort, decoction.	1 quart.	1 quart.	½ pint.	
Excessive pain.	Chloroform.	1 teaspoonful.	1 teaspoonful.	⅔ teaspoonful.	Given in water.
" "	Morphine.	2 to 5 grains.	5 grains.	½ to 1 grain.	Given in tissue paper, repeated in 1 or 2 hours.
" "	Opium.	⅛ to ¼ oz.	½ oz.	10 to 20 grains.	Combine opium and laudanum in case of great pain from stoppage of water.
" "	Laudanum.	1 to 2 oz.	2 oz.	⅛ oz.	
Acidity of stomach.	Soda.	1 oz.	⅔ oz.	½ oz.	
Urinary affections and fever.	Saltpetre.	1 oz.	⅔ oz.	½ oz.	
	Sweet spirits of nitre.	1 to 2 oz.	¾ oz.	¼ oz.	As a diuretic.
Costiveness.	Castor oil.	1 pint.	2 to 4 oz.	⅔ oz.	As a carthartic.
"	Rhubarb.	1 to 2 oz.	2 oz.	½ to ⅔ oz.	As a laxative.
Spasms.	Camphor.	⅛ to ¼ oz.	½ to 2 grains.	1 to 2 grains.	In mucilage.
Worms.	Spirits of turpentine.	2 oz.	¼ to ⅔ oz.	½ oz.	

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